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ABSTRACT

A workshop was organized to: (1) exchange ideas, views, teaching materials, and experiences between all individuals involved in present science education projects; (2) familiarize staff of the Lesotho Science Pre-Entry Course (LESPEC) with the working situation in these types of projects; and (3) start discussions of policy matters related to the aims of these programs in view of the needs of science education in the southern Africa region. Presented is a summary of the workshop, including objectives, organization, subject area discussions, policy discussions, conclusions/recommendations, and workshop evaluation. Subject area discussions focused on an interdisciplinary approach, programmed instruction and open labs/teaching approaches, ability grouping, and educational objectives related to biology, chemistry, physics, mathematics, and English. Also included are discussions of teacher education, educational improvement, defining target groups (focusing on target institutions, issue of bonding, need for streaming, and issue of direct entry), methods and problems of selection, and position of projects in the educational system. The program, a list of participants, and a list of the position papers are included in the appendices. Position papers are categorized by and presented in the same order as topic areas in the subject area discussions, and make up the major portion of the report. (JN)

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REPORT OF THE INTERUNIVERSITY WORKSHOP

SCIENCE EDUCATION IN SOUTHERN AFRICA

PRE-ENTRY SCIENCE COURSES AND SCIENCE TEACHERS' UPGRADING PROGRAMMES

FREE UNIVERSITY AMSTERDAM
UNIVERSITY COLLEGE OF BOTSWANA
NATIONAL UNIVERSITY OF LESOTHO
UNIVERSITY COLLEGE OF SWAZILAND

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CONTENTS

1. Introduction Page 1

2. Objectives 2

3. Organization 3

4. Discussions 4

5. Summary of policy discussions 16

6. Conclusions and recommendations 18

7. Evaluation 19

8. Appendices 20 – 125

EDITOR

Dr. G.D. Thijs
Organizing Secretary
Interuniversity Workshop
Science Education in Southern Africa

1. INTRODUCTION

In the programmes of cooperation between the Free University Amsterdam (FUA) and the University College of Botswana (UCB), the University College of Swaziland (UCS) and the National University of Lesotho (NUL), Basic Sciences form a particular field. In this field the following projects have been started:

In 1977 UCB/PESC	Pre-Entry Science Course Upgrading students for science based university programmes through an annual 6 months remedial course for 120 (from 1977-80), 150 (in 1981 and 1982), 180 (in 1983 and onwards) secondary school leavers
In 1978 UCS/SPEC	Science Pre-Entry Course Similar course as PESC for 120 students.
In 1979 UCS/STU	Science Teacher Upgrading Related to SPEC an in-service training of secondary school science and mathematics teachers.
In 1980 NUL/AMSTIP	Accelerated Mathematics and Science Teacher Improvement Upgrading of science and mathematics secondary school teachers through a two-year diploma programme of in-service and full-time courses.
In 1981 NUL/LESPEC	Lesotho Science Pre-Entry Course Upgrading of students for science-based programmes at the university and teacher training, agricultural and technical colleges through an annual 5-months remedial course for 100 (in 1982), 120 (in 1983), 150 (in 1984 and onwards) secondary school leavers.
NUL/EMES	Educational Measurement and Evaluation in Science This EMES project is in preparation as a sub-programme of LESPEC in order to develop tests for selection of suitable candidates for entry into the course.

At FUA the supervisors of the above projects participate in the so-callled Working Group "Basic Science Projects" (BSP). This working group discusses common problems encountered in the execution of the programmes and coordinates actions related to particular aspects of the projects. By letter of 2 October 1981 the BSP Working Group proposed to all supervisors and staffmembers of the above projects to organize an interuniversity workshop in Lesotho, in the beginning of December 1981. The aim of such a regional meeting would be to systematically discuss experiences gained and problems met in the execution of the projects.

The working group also proposed to invite Dr. G.J.C. van der Horst, deputy director of the Netherlands Universities Foundation for International Cooperation (NUFFIC), for the workshop. Dr. van der Horst had indicated a particular interest in the meeting, also in view of the proposal of NUFFIC to organize a seminar on 'Pre-Entry Programmes in Southern Africa' with other donor agencies (such as the European Development Fund), in 1982. The workshop as proposed by the Working Group could also be seen as a preparing excercise for this seminar.

The Working Group's proposals received a positive response. After some correspondence the dates of the workshop could be fixed on 2 - 5 December 1981. In the next sections the objectives of the workshop, the organization and a summary of the discussions are given. Conclusions drawn and recommendations made, are mentioned in section 6. Finally, a short evaluation of various aspects and results of the workshop is given.

2. OBJECTIVES

In the letter of 2 October 1981 the Working Group 'Basic Science Projects' specified the objectives of the workshop in the following way:

1. To interchange ideas and views, teaching materials and working experiences between all people involved in the present projects.
2. To familiarize the staff of the LESPEC course (starting in 1982) with the working situation in these types of projects.
3. To start a discussion on policy matters related to the aims of these programmes in view of the needs of science education in the Southern African region.

As to the third objective, the Working Group stressed the informal character of the meeting in a letter (dated 12 November 1981) to all project supervisors and staffmembers.

"The workshop aims at an interchange of views of teammembers, supervisors and other professionals on the projects, both on subject contents and on policy implications. We certainly do not imagine to be in a position to advise university or Government policy makers what to decide on developments in the university or the general educational system in the countries. However, we would like to use the opportunity of the meeting to discuss also fundamental aspects related to the very objectives and perspectives of the projects. Such discussions could be fruitful to prepare suggestions for policy makers in the various countries concerned. We will ask the teams/supervisors to give an extensive report of the meeting afterwards to their respective university authorities, who can decide whether locally discussions with university and/or Government officials on some topics are relevant."

3. ORGANIZATION

The coordinator of the FUA Working Group 'Basic Science Projects', Dr. G.D. Thijs, acted as organizing secretary of the interuniversity workshop. Originally the Working Group planned to invite all staffmembers involved in the projects for the workshop.
However, due to budgetary constraints the number of delegates from Botswana, Swaziland and The Netherlands had to be limited. In Lesotho all institutions participating in LESPEC were invited to send delegates to the workshop. Apart from NUL the following institutions participate in LESPEC: the National Teacher Training College (NTTC), the Lerotholi Polytechnic (LP) and the Lesotho Agricultural College (LAC).
The final number of participants (listed in Appendix A.3.)amounted to 34 distributed as follows:

NUL	- 17
UCB	- 7
UCS	- 5
FUA	- 4
NUFFIC	- 1

The programme of the workshop is shown in Appendix A.1.

On behalf of the Vice Chancellor of NUL, Mr. A.L. Williams, LESPEC project supervisor, made the opening address. He welcomed the workshop as a useful starter for the LESPEC project. This project is rather complicated since it has to cater for various institutions. Therefore, the newly recruited project team could learn quite a lot from experiences collected in the other projects.
The first two days of the workshop (2 and 3 December) were spent on subject discussions which were held in 6 seperate groups: Biology, Chemistry, English/Study Skills, Mathematics, Physics and Teacher Training. The composition of these subjectgroups is indicated in A.3. The subject discussions took place in the Maths Science Centre in Maseru.
The last two days (4 and 5 December) were used to discuss policy matters and were held as plenary sessions in the Conference Room of the National Curriculum Development Centre in Maseru. The chairpersons of these sessions are mentioned in A.3.
All participants had been invited to produce position papers on the themes of the subject discussions (S/1-S/4) and the policy discussions (P/1-P/4). Project teams were also asked to send in advance their position papers and systematically arranged teaching materials used in their courses to contact addresses in the other countries. This procedure was planned to optimally prepare the participants for a fruitful discussion. For the workshop 39 position papers were produced (see list A.5.), 7 of which were prepared at FUA.
The closing remarks of the meeting were made by Dr. Thijs. He expressed his gratitude to the hosting institution, the National University of Lesotho, and the LESPEC and AMSTIP staff, for making available and arranging various facilities for the meeting. He also thanked the participants for producing position papers and contributing to the discussions.

4. DISCUSSIONS

In this section the review of the subject discussions (S/5 on the programme mentioned in Appendix A.1) is reported, as well as the policy discussions P/1-P/4. The themes S/1-S/4 and P/1-P/4 as proposed for the discussions, are worked out in more detail in A.1.

4.1 Review of subject discussions(S/5)

Each subjectgroup (see A.3) reported on the discussions held on the themes S/1-S/4. The reports of the subjectgroups were followed by a general discussion. The overall report of the subjectgroup 'Teacher Training' is given at the end, in section 4.1.5.

4.1.1 Interrelation of the subjects in the courses (S/1)

As to the interrelation of subjects the following comments were made.

Biology:

A general theme (such as: sewerage, soil, energy, ...) to be dealt with in the various subjects from different points of view, could be useful. Such an interrelated teaching approach could better take place in the end of the course than in the beginning.
General lectures and talks related to excursions to institutions of applied science (water purification, game reserve) could also offer an interesting possibility for interrelation of subjects.
Treating history of science could be rather difficult because of cultural differences. Do African students have the same sense of history as Western students?

Chemistry

History and philosophy of science, as well as talks on 'science and society' should be essential components of the course.

Physics

A distinction should be made between coordination and integration. Coordination is absolutely necessary. Integration is more difficult since each science subject requires its own planning for developing concepts. Also, integration between the subjects is less important than relation with daily life experiences and environment. Also important is the interrelation between science subjects and English/ Study Skills. As an example: the English lecturer could show note making of the general lectures by using overhead projector pictures.

Mathematics

Topics dealt with in Maths should be coordinated with different science subjects. All subjects should have uniform notations and follow the same lines in drawing of graphs and use of units. Problems treated in Maths could be derived from science.

English

The English lecturer should remedy deficiencies of the students as observed by the lecturers in the science subjects. Double marking of the students' laboratory reports and assignments could be made, both on the science contents as on the English level. Subject matter should be derived from textbooks in science and history of science. Finally, the English lecturer has also a service role in guiding the lecturers for which English is a second language.

General Discussion

Apart from interrelation with other subjects, also the coordination with the teaching programmes in the target institutions (e.g. various departments in the Faculty of Science or Faculty of Education at the university, Teacher Training Colleges, Technical and Agricultural Colleges) is important. Relating the teaching to the environment would be most needed in the subject Biology.

4.1.2 Programmed instruction and open labs/teaching approaches (S/2)

Biology

Open labs offer more freedom, responsibility and possibilities for experimental thinking then more guided labs. They also emphasize other skills e.g. report writing. However, the level of students limits the open lab approach. Tests should always contain essay questions since they are very useful to analyze the type of mistakes students make. Concerning multiple choice (MC) questions it is considered questionable to penalize students for guessing.
A compromise would be to instruct the students 'Make sure that you guess right'.

Chemistry

Open labs are useful if geared to clearly defined educational objectives. However, it requires the availability of basic skills which need to be taught first in a strongly guided approach. In tests MC questions are appropriate for lower levels of educational achievement and useful to cover large parts of the syllabus. MC questions should be carefully developed; item-analysis is indispensable.

Physics

The practical approach in the course should move gradually from guided to open labs. To prevent students from blindly following the instructions many questions should be inserted in the instruction sheets. In the lecture following the lab the teacher should spend time on clarifying towards the students the concepts dealt with in the practical. The question is raised whether a practical is always needed to transfer concepts. In tests essay questions could be used to analyze the weaknesses of the students. Construction of good MC questions takes much more time than designing good essay questions.

Mathematics

It would be useful to prepare question banks. Essay questions should be preferred to MC questions; the latter do not force the student to write out the solution in an organized way.

English

Carefully designed MC questions are good objects to instruct students in comprehension, by explaining the differences between the various possibilities and the underlying roots. To promote logical thinking true-false questions could be analyzed.

General Discussion

Do students really gain much from report writing on the practicals performed? They mostly consider report writing as a dull exercise! However, lab reports offer the opportunity for an intensive feedback on the practical activities towards the students.
Since most of the time in the science subjects is spent on practicals, a practical test should be included in the final assessment.

4.1.3 Streaming within one subject (S/3)

Biology

Streaming of students into bright and weak groups would not be advisable. Better approaches to the variety in the students' ability would be: optional assignments, organized homework, periods with more flexibility in teaching and assistance to the weaker students, science club projects for the better students, etc.

Chemistry

Streaming could only be needed if the course aims at institutions with different entry levels. Additional tutorials could easily overload the weaker students.

Physics

The problem of streaming is the need to identify weak and bright students in an early stage of the course. A better solution would be: smaller classes, remedial tutorials (restricted to the weaker students), optional assignments for the brighter students.

Mathematics

The problem of the variety in the students' ability could be solved in the following way. Designing a basic course, which defines the minimum pass level of the course, for all students and a graded course (indicated by 2 and 3 star questions) for the brighter students.

English

Streaming would not be needed in this subject since all students are weak in English. The main concern of the English lecturer is to have manageable groups.

General Discussion (see also 4.3)

How do we encourage bright students to help the weaker ones? It could be done by making subgroups of mixed ability. The lecturer could try to identify bright students and to let them act as group leaders.
At FUA the Physics Department has done research on teaching methods for mixed ability groups. This research resulted in a method

'Differentiatie Binnen Klasseverband' (DBK). It should be investigated whether this DBK method could be used in the pre-entry courses.
Will bright students be stimulated by grading of questions? What are the incentives for answering graded questions, if this activity would not be accounted for in the final mark?
In education socialization is necessary. The teachers are responsible for this process. If they give stars to bright students they might make them monsters!The identification of bright students is still a problem.
A student which is bright this week may be weak next week.

4.1.4 Educational objectives (S/4)

Biology

The biology lecturer should not be too concerned about specific parts of knowledge (the basic contents in biology are mainly from chemistry, physics, maths) but about basic skills: abilities to observe, measure, record through drawings and tables, interpret data, deduce logically, take samples, think clearly, etc. These skills are much more important than a mere repetition of O-level contents.

Chemistry

The educational objectives are: consolidation of O-level, reaching a homogeneous level of knowledge for all students, preparation for the next stage of science based studies.

Physics

An educational objective is to understand essential principles in basic fields of physics.

Mathematics

A main objective is to eliminate rote-learning.

English

English should be seen as a tool to comprehend the other (science) subjects.

General Discussion

There are very basic parts of scientific knowledge which should be taught anyhow to all students. This basic core of the course should be determined by the target institutions. If a heavy emphasis is put on the acquisition of basic skills, we should also test these skills in the examinations.

4.1.5 Teacher Training

In Botswana the situation with respect to the presence of unqualified teachers is different from Lesotho and Swaziland. In Botswana there are no unqualified teachers except at the Community Schools.
The Government of Botswana plans to start a Teacher Training College in Molepolole by 1984, to cater for the increasing need for teachers as the number of junior secondary schools will increase. The Government encourages local communities to start a school.

If a certain level of organization has been reached, the Government is prepared to provide assistance.
The discussion concentrated on Lesotho and Swaziland. In both countries there are about 100 unqualified experienced teachers at Junior Secondary School level. These teachers should be upgraded for entry into National Teacher Training College (NTTC) in Lesotho/William Pitcher Teacher Training College (WPTTC) in Swaziland.
A number of questions were discussed, concerning: selection of the teachers, the subject matter to be offered in the upgrading course, the duration and the way of training (full-time or part-time).
For these questions use could be made of the experiences gained in STU and AMSTIP as well as with the WPTTC students who were channelled through the SPEC course.
A possible scheme for upgrading unqualified science teachers at Junior Secondary level could be: a practically based in-service course preparing for entry into SPEC/LESPEC which should then enable the teachers to be admitted into WPTTC/NTTC.
As other means of assistance to teachers were mentioned: organizing post-graduate workshops, production of cheap equipment with materials locally available and audio visual aids.

4.2 How to improve secondary education? (P/1)

The interuniversity projects (mentioned in section 1) are mainly correcting the present system and its products. It should be considered to make more efforts in promoting teacher training and improving the present system through services to teachers and schools. The following activities could be thought of:

a) Advising on the most important topics in COSC through workshops and curriculum development units. This is badly needed since the COSC curriculum is hardly specified and not that much structured.

b) Assistance in the production of manuals for unqualified teachers - day to day teacher guides for subject matter organization (like the manuals issued by the Extension Colleges).

c) Advising on the choice of more uniform COSC subjects packages for the students of the science stream, and on the choice of the most appropriate core textbooks.

d) Advising on the relation between the JC and COSC syllabus. There is an immediate need for articulation between the syllabuses.

For Lesotho a suggestion is made to assist commanding schools in staff and teaching materials, using the breathing time in LESPEC, until these schools produce students for direct entry into NUL.
Such assistance could also be realized by inviting teachers of these schools for participation in LESPEC, from June-July, so that they could witness the teaching approach and pick up skills for use in their own schools. Also materials for schools with smaller budgets could be produced.
This suggestion does not make sense for Botswana since most of these teachers are expatriates and already qualified.
In Swaziland such an effort is made through STU/SPEC. However, this

project aims at the entire country and does not concentrate on specific schools.

As to the educational structure, the scheme advocated in position paper 22 (3 years BSc study after 3 years high school education) meets fierce opposition. Some propose, instead, after O-level a 2 years A-level study and a 3 years BSc programme. Others stress that not the secondary schools should adjust themselves to the needs of the university but the other way around, considering that only a very small percentage of secondary school leavers become university graduates. Various comments are made on several elements in the educational structure. Some feel that most problems originate from primary education. Manipulating fractions should in fact be taught in Standard 5 and not in the pre-entry course. Both the present primary education and the JC system are considered to fail in preparing students for the society.
In Botswana the Government considers to change the JC education more into technical and vocational training. That would leave the senior secondary schools with a bigger job to teach the academic contents. As a result of this, a continued need for a pre-entry science course will be expected in Botswana.
A question arises why small groups should be trained as scientists leaving the majority out? Why in fact are we teaching science? An answer suggested: development implies that there are people who have scientific literacy.
The science education problem as a whole is considered as too big. In fact we should not lock at the whole spectrum, but confine ourselves to areas where the university can be most effective. Most of the participants (particularly the expatriates) lack competency and position for measures of change. Confining ourselves to our project objectives we even find unsatisfactory results in practice. For example in Botswana, the very PESC objectives (upgrading incoming students/producing more teachers) are already hard to combine since most of the best upgraded students go abroad, either after PESC or after Part I, and do not become teachers. To change this undesirable situation, it should be tried to convince the policy makers in the field of bursaries allocation of another strategy.

4.3 Defining the target group (P/2)

The discussion concentrated on the following topics: target institutions for which the students in the courses are prepared, the issue of bonding, the need for streaming, and the issue of direct entry.

Target institutions

In Botswana the target institution of PESC is mainly the university, either the Faculty of Science (BSc-degree programme) or the Faculty of Education (DSE, Diploma in Secondary Education - Science programme). To channel the students into Education the Government considers a

quota system governed by a bursary system. The Government limits already the intakes into the Faculties of Humanities and of Economic and Social Studies based on COSC results. The planned Faculty of Agriculture will presumably have its own pre-entry course.
In Swaziland the target institutions of SPEC are: the Faculty of Science (into which about 80 SPEC students are admitted yearly) and WPTTC (into which about 10 SPEC students are admitted yearly). The Institute of Health Science (IHS) and the Swaziland College of Technology (SCOT) intend to start their own pre-entry courses. Also the Faculty of Agriculture has its own pre-entry programme. In fact the capacity of SPEC is too small to cater for all these institutions.
In Lesotho the target institutions are the Faculty of Science of NUL (not more than 45 LESPEC students to be admitted yearly,in addition to the 30 direct entry students), the NTTC, the Lesotho Agricultural College (LAC) and the Lerotholi Polytechnic (LP). All LESPEC students had to sign a statement of going into science based studies. Possibly most students prefer to go into NUL or LP. The other institutions have not shown much eagerness to get more students so far.

Bonding

The following suggestions are made to increase numbers of science students and potential science teachers:

- ask those students who opt for a non science based study, to repay their course bursary
- do not select the top students for the course, but weaker students who would not have many options open based on their COSC results
- after publication of the COSC results the students have to apply for bursaries. Ask the students who apply for a non-science based study to leave the course and admit at that time new students who really aim at a study in science

From the Botswana side the following comments are made:

- repayment of the course bursary could only be considered if the student will not be sponsored for further students by Government, but by a private company
- the preferences of the students can change during the course, in spite of the fact that at the start they signed a statement of intending a science based study. Many students accept an invitation for entry into PESC, because they consider the course as an insurance against bad COSC results
- the students who enter PESC after publication of the COSC results are mostly not that successful (about 20% of them pass the course).

From Swaziland side the comment is made that also in that country the Government has not a clear quota policy for scholarships. It would, therefore, be difficult to realize in SPEC a strategy for repayment of bursaries in some cases. Also, it would not be wise to force students into science if they are not motivated to do so. They should then be allowed to go into other faculties.

Streaming

In the past the pre-entry courses were started to compensate for science deficiencies in COSC performances, and not to cater for specific wishes of post secondary institutions. The objectives of the courses are, therefore, to consolidate O-level. Because of the general weakness of the students, streaming is not considered to be advisable.

Streams in the pre-entry course treating specific subjects which are particularly useful in the following institutions, would in fact imply extending the courses of these institutions with half a year.

Streaming would require to identify students for the various streams from the very start of the course. This identification process is very difficult. Also in view of the previous discussions of the subject groups, it was concluded that streaming of the existing programmes would not be desirable.

Direct entry

From Lesotho side the comment is made that direct entry into NUL has the advantage that LESPEC could train more students for other institutions. For the Faculty of Science (FOS) of NUL the course would hardly be needed if only numbers of students are considered. Before the start of LESPEC, in 1981, 80 students were admitted into year I of FOS (60 based on COSC, 20 through a pre-entry course of 3 months). If the results of the one-month workshop for the direct entry students would not be satisfactory in the future, the workshop could be replanned. The level of the direct entry students who attend the workshop should be evaluated, in comparison with the performance of the LESPEC students. If the level is considered as appropriate the direct entry solution has the advantage of being more cost effective. Based on experiences in the past the FOS/NUL expects reasonable results of a one-month workshop for the direct entry group.

From Botswana and Swaziland side the suggestion for direct entry, as made in position paper 28, is considered to be a belated argument. The 6 weeks pre-entry workshops in these countries that were arranged in the past, before PESC and SPEC started, were considered as being much too short and inadequate, even for the best students. Good COSC results do not guarantee a good science level in practice; always gaps in knowledge and skills exist. The following additional drawbacks of the direct entry solution are mentioned:

- it introduces a heterogeneity in the first year in FOS (full pre-entry course students versus direct entry students, who attended the short workshop)
- students selected for direct entry are left idle between November and August of the following year
- there is no commitment from the students selected for direct entry to enter finally FOS. They could easily be attracted away by the private sector.

4.4 Methods and problems of selection (P/3)

The topics discussed concerned: the achievement tests, the aptitude tests, the teachers' ranking and the categories of students who are admitted to the selection tests.

Achievement tests

For all pre-entry courses mathematics achievement tests are used in the selection. The maths tests used for the selection of students for LESPEC 1982 resulted in a low mean score (26%) which makes its use in the selection criterion not that reliable.
In the selection for PESC besides a maths test also a science achievement test is used.

Aptitude tests

A number of years aptitude tests obtained from the Department of Organizational Psychology FUA have been used in PESC and SPEC. The scores of these aptitude tests do not convincingly correlate with the students' results in the pre-entry course and the results later on in the Faculty of Science. The effect of the aptitude tests has been analyzed in the Second Report PESC 1981 in section 1.6.2. This report concludes that 'the inclusion of aptitude tests produces no significant positive or negative effects on the number of students passing PESC'. It should, however, be realized that the aptitude tests' scores were given only a weight of 17% in the PESC selection criterion (see position paper PP31).
In Lesotho aptitude tests were administered during the visits of the LESPEC staff to schools. However, the tests' scores were not considered in the selection, except in borderline cases.
There is clearly a need for validating the aptitude tests. Such process will be aimed at in the proposed EMES programme. Unless the aptitude tests have really been validated, it would not be justified to rely heavily on the aptitude tests in the selection. Some participants of the workshop express the feeling that the pre-entry course level is too late a stage to use aptitude tests. Rather such tests should be used at an earlier level e.g. to advise Form D students to go either into the science stream or the non-science stream. Others, however, argue that there is still a need for aptitude tests in selecting students for the pre-entry course. This is especially the case in a situation where schools differ considerably in quality and assessments of students by teachers are not fully reliable.
If aptitude tests are to be used for selection, more systematic efforts have to be put in developing good tests then the occasional activities that took place in the past few years.

Teachers' ranking

It would be useful to instruct teachers more clearly on how to rank their students in order of merit. The teachers should not only consider results of mock examinations, but also account for expected aptitude in science and motivation of the students. In what way should we combine the test results and the teachers' rankings? In the selection procedure of PESC and LESPEC the teachers' ranking is transformed into predicted testscores. In PESC special attention is paid to the effect of the size of the school to prevent favouring of schools with large numbers of students (see PP31). For LESPEC the teamleader reports on the first selection procedure recently executed. Based on the average performance in the maths tests, the Lesotho schools were classified into three groups of: good - medium - poor performance. The transformation of the teachers' ranking into predicted testscores, was performed separately for each group of schools (see PP30).

Categories of students

For all pre-entry courses the students admitted to the selection tests should have taken: Mathematics, English and Science as subjects for the Cambridge examination. In the PESC selection process the science condition is specified as implying the following subjects: Physical Science, or General Science, or two separate science subjects (i.e. Biology, Chemistry, Physics). Human and Social Biology and Agricultural Science are not acknowledged as science subjects in this condition.

4.5 Position of the projects in the educational system (P/5)

The views on the position of the projects are rather different, dependent on the country where they take place.

Swaziland

- Right from its inception SPEC has been considered as an emergency measure, needed as long as the secondary schools do not produce students of a satisfactory science level. This situation is due to the lack of competent teachers in the schools. By 1985 it will be seen whether the shortage of skilled teachers has been remedied and SPEC can be phased out.
- All students of the Faculty of Science (FOS) have to take the Concurrent Certificate in Education (CCE). However, no student is forced to go into the teaching profession. Therefore, there is no guarantee that in making CCE compulsory the policy of producing teachers will be successful.
- In Swaziland the chances of producing teachers are better than in Botswana, since there is a smaller demand for BSc graduates by the private industries. However, apart from the labour market, it is equally difficult to influence the Government on manpower planning. Also in Swaziland there does not exist a consistent and rigid policy for allocation of bursaries by the Government.
- There is a need for an adequate policy of the Government with respect to the secondary education. However, the science teachers themselves should press for support and further improvement of services rendered towards the schools.

17

- The STU project will become a permanent part of the Faculty of Education (FOE). It is expected that there will be a continuous need for upgrading underqualified science teachers in the future.
- There has been an influence of the existence of the SPEC project on the other faculties of UCS. Also the Faculty of Economic and Social Studies is concerned about the level of the students in the subjects English and Mathematics. However, so far no plans for other pre-entry courses have been made.

Botswana

The intended changes at junior secondary level in Botswana will lead to loss of academic content in favour of more vocational content. Although this will benefit the experimental skills of prospective science students, it will also require a compensation for the loss in content. Presumably the basic educational structure 7-3-2 (primary-junior secondary-senior secondary) will not be changed. Therefore, it could be expected that PESC will become a more permanent feature of FOS, to make up for the loss in academic content at secondary level.
Over the current period of the existence of PESC, there has not been a significant increase in the number of students going into teaching. The following aspects of the present situation are really alarming. At the end of PESC the best students are sent abroad for programmes which are mostly not available in Botswana. At the end of Part I in FOS, the majority of the students are transferred to programmes in other countries. It is very difficult for the university to influence the Government authorities to change this undesirable situation. However, there are some positive developments at higher policy level towards considering of quota systems and allocation of bursaries to promote students going into teaching.
The existence of PESC has influenced some other faculties of UCB to think of the need of a pre-entry course. However, so far no plans for other courses have been made.

Lesotho

The number of FOS graduates going into teaching has not been substantial so far. Of the yearly number of about 28 BSc graduates only about 8 enter the teaching profession. The Ministry of Education is not very alert in this situation. The university staff can only make observations and suggestions. However, there is a need for up-to-date manpower reports and a clear policy of the authorities as to the production of teachers. Due to the presence of AMSTIP and the number of drop-outs in the FOS programme, there are many more students in the Dip.Ed.Sc. programme than students in the B.Sc.Ed. programme.
In Lesotho the teachers move away from their profession because of many reasons. Other civil servants have better facilities, fringe benefits and chances for promotion.
A possible impact of LESPEC can not be expected before 1990, considering the length of the educational programmes at NUL and NTTC. However, the project authorities should stress that it is essential

to get teachers via the project. Another important issue is the counterpart training of the project staff. It is necessary that this is included in the standing NUL localization policy if LESPEC is going to be a long-term project.

General Discussion

Is 5 to 6 months the ideal length of a pre-entry science course? Would not a course of 1½ year offer better chances to disadvantaged students to reach an academic attitude (see also PP39)? Some participants advocate that such a course has the advantage of exposing the students during a longer period to a uniform and more adequate teaching approach. Also, the students are more mature when, at the end of such a course, they have to decide on their future careers. Others, however, argue that the pre-entry courses should have only an introductory character. In fact the present common first year in the Faculty of Science has already an exploratory character and does not offer specialized subjects.

5. SUMMARY OF POLICY DISCUSSIONS

In session P/5 the following elements were considered to be the highlights of the previous sessions on policy discussions. Abbreviations used are listed in Appendix A4.

P/1 How to improve secondary education

The participants of the workshop do not feel competent to discuss the educational system as a whole. However, the group would like to assist in activities to improve secondary science education, together with Ministry of Education, Science Teacher Association, Department of Science Education of the University, Teacher Training Colleges, through specific projects e.g.

1. Boosting intakes of students into teacher training programmes
   - Bachelor of Science (BSc) programme
   - Diploma in Science/Secondary Education programme (Dip.Ed.Sc/DSE)
   - Secondary Teacher Certificate (STC) programme

2. Upgrading unqualified high school teachers, from STC to Dip.Ed.Sc. level and unqualified Junior Secondary teachers up to STC level.

3. Other possible activities, such as:
   - involving teachers in the existing projects
   - organizing workshops for teachers
   - indicating essential elements in the COSC syllabus
   - advising in choice and use of textbooks and defining consistent packages of subjects for the COSC examination
   - curriculum development

P/2 Defining the target group

1. The pre-entry courses cater for different institutions in the three countries. In Botswana PESC/UCB caters mainly for the university (BSc in FOS and DSE in FOE).
   In Lesotho LESPEC/NUL caters for NUL (FOS), NTTC, LP, LAC.
   In Swaziland SPEC/UCS caters mainly for the university (FOS) and WPTTC.

2. The aim of the pre-entry course is mainly to consolidate O-level and not to introduce elements dealt with in the post-secondary institutions.

3. Therefore, streaming of the programmes in view of the different target institutions is, in principle, not desirable.

4. Also contentswise, streaming of the programme for students of different level of performance would not be desirable since it would prevent a student from socialization. Streaming would only be needed in cases where the gap to be bridged for the students is too big.

5. Botswana and Swaziland feel that there should not be a direct entry group, all students should attend the 6 months pre-entry course to make up for the various deficiencies which all students have.

6. As to the need of direct entry, the situation in Lesotho is different since LESPEC has to cater for many institutions. It has to be evaluated whether the level of the direct entry group will be adequate for the university.

P/3 Methods and problems of selection

1. Teachers should be clearly instructed as to how to rank their students carefully.

2. Also they should be asked to assess the aptitude, motivation and perseverance of their students and take these qualities into account in their ranking.

3. Aptitude and achievement tests need to be validated. If the tests do not meet confidence they cannot be used as selection instruments.

4. Maybe the entrance of the course is too late a stage to use aptitude tests. They possibly have to be administered two years in advance, e.g. at Form IV (D) level.

P/4 Position of the projects in the educational system

1. Swaziland considers SPEC as an emergency measure. By 1985 it will be seen whether satisfactory production of teachers has taken place. The STU project will be integrated as a permanent activity into the Faculty of Education.

2. Botswana considers PESC to be a more permanent feature in view of:
   - loss in academic content at secondary level to be expected in a changed educational structure
   - failure so far of a satisfactory production of local teachers
   - increasing need for science graduates in other fields than education

3. Choices of studies and careers by students who passed the pre-entry course, are beyond control of project and university authorities. To promote students going into the teaching profession there is a need for a consistent government policy for allocation of bursaries.

4. Final aim of the projects should be localization i.e. making donor assistance unnecessary. A proper localization scheme should be included in each Plan of Operations, after having passed the experimental stage of the project. The projects should have spin-off effects both to the secondary schools and to the target institutions.

6. CONCLUSIONS AND RECOMMENDATIONS

In session P/5 some confusion arose amongst the participants as to the means available for implementing policies on science education. Some participants advocated asking FUA or donor organizations like NUFFIC, to put pressure on the governments in the countries to ensure implementation of desirable changes. However, it was made clear that FUA and donor organizations could only back up partner university institutions in their advocating new policies, instead of dealing directly with governments.
Finally, the sessions resulted in the following general recommendations:

a. Continuous exchange of information between staffmembers of the various pre-entry and teacher training programmes should take place regularly, stimulated by the working group of project supervisors at FUA

b. Regional meetings like this workshop are useful and should be held in each period of three years.

c. Possibilities should be investigated for improving selection instruments,especially with a view to identifying students with poor educational background which have potential for succesfully completing science based tertiary programmes.

d. The outcome of this workshop should be fed back to all relevant local authorities on education in the three countries (Ministry of Education, University, Science Teacher Association, Teacher Training Colleges) by local project supervisors and teamleaders, and to FUA by Dr. Dulfer.
The results of this workshop should be discussed at local level in order to consider steps to be taken to find creative solutions to identified problem areas.

e. Participants of this workshop express that there is a clear need for assistance by the policy makers in these countries in order to ensure that enunciated policies towards science education and teacher training are implemented.

7. EVALUATION

The objectives of the workshop had been specified as follows:

1. To interchange ideas and views, teaching materials and working experiences between all people involved in the present projects.
2. To familiarize the staff of the LESPEC course (starting in 1982) with the working situation in these types of projects.
3. To start a discussion on policy matters related to the aims of these programmes in view of the needs of science education in the Southern African region.

As to the first objective, the workshop can be considered as having been very successful.The contacts made between subject specialists of the project were stimulating for the development of ideas. The informal, friendly, atmosphere of the discussions contributed a lot to this success of the workshop.

As to the second objective, the workshop was very useful to inform the new LESPEC team on comparable working situations in the other projects. It was a pity that two LESPEC staffmembers recently recruited in The Netherlands were not able to attend the workshop. Also regrettable was the absence of delegates from NTTC, LP and LAC in the meetings,which wrongly suggested as if LESPEC were only an effort aiming at NUL.

As to the third objective, the policy discussions held were useful to compare the difficult situations in the three countries. It was striking that even in comparing the three Boleswa countries the options advocated in practice are rather different:

- Direct Entry : to be realized in Lesotho, rejected by participants from Botswana and Swaziland
- Target institutions : a large variety in Lesotho, mainly the university in Botswana
- Secondary Schools : different variety in the quality of the secondary schools , especially comparing Botswana to Lesotho and Swaziland. This situation has implications for the selection procedure to be followed.
- Institutionalizing : Swaziland aims at phasing out SPEC in the future, Botswana considers PESC as a more permanent feature.
- Labour market for graduates: In Botswana much more competition from scholarships offered by private companies than elsewhere. This has consequences for the teacher production and the number of students in the Part II phase of the university programme.

This observation should be taken into account in case a seminar were planned, where more heterogeneous countries in the Southern African region would be represented. It could be expected that the approaches of a particular problem, followed by the various countries in such a seminar, would be very diverging.
Concerning the organization of the policy discussions the following comments can be made:

- The last two days were too crowded. An interval should have been inserted on the programme to quietly prepare the recommendations of the last session.
- The plenary sessions were too big; it would have been better to prepare these discussions in smaller groups.

On the whole the workshop can be characterized as a stimulating and fruitful exercise. The participants were forced to articulate themselves on systematically defined subjects and themes related to the project activities.
Finally, the support should be acknowledged of all institutions that have made the workshop possible: the University College of Botswana, the National University of Lesotho, the University College of Swaziland, the Netherlands Universities Foundation for International Cooperation, and the Free University Amsterdam.

8. APPENDICES

		Page
A.1	Programme	21
A.2	Review of all staffmembers and supervisors	23
A.3	Participants, subject groups, chairpersons	24
A.4	List of abbreviations used	26
A.5	List of positions papers	27
	Position papers PP1 | PP39	28 | 125

A.1

PROGRAMME OF THE MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES, 2 - 5 December 1981

PLACE: Maths Science Centre in Maseru, Lesotho (2 and 3 December 1981)

Wednesday, 2 December 1981

08.30 - 09.30 a.m. Registration; composing subject groups of specialists in the fields of teaching biology, chemistry, english/studyskills, mathematics, physics and teacher training.

09.30 - 10.00 a.m. Opening address.

SUBJECT DISCUSSIONS

10.00 - 12.00 a.m. S/1[*] Interrelation with other subjects of the course

Ways and means for integration of the subjects e.g: choosing elements in the syllabus which are useful for the other subjects, selecting common themes or areas of interest (water, soil, energy,......),providing general lectures (such as on 'science and society', 'history/philosophy of science'), promoting the same types of skills, following a coordinated teaching approach in the various subjects, etc.

02.00 - 04.00 p.m. S/2[*] Programmed instruction and open labs/teaching approaches

To what extent should the teacher spoon feed the students? At which stage during the course should the student (occasionally) be left alone in a situation without being provided with straight indications as to how the problems should be solved. What are the merits of multiple choice questions and of essay questions in tests?

Thursday, 3 December 1981.

09.00 - 11.00 a.m. S/3[*] Streaming within one subject.

Is there a need for streaming considering the variety in educational backgrounds of the students and considering the variety in programmes the students enter after completion of the course (e.g. agriculture, teacher training)? How should this be done, by :
- individualization e.g. by following a module system;
- paying more attention to weaker students e.g. by tutorials;
- offering a less complicated programme to weaker students;

At what stage of the course should streaming be considered. Is reducing of class size an alternative to streaming?

03.00 - 05.00 p.m. S/4[*] Educational objectives

Which are the essential concepts and skills within the subject? Are there particular elements that should be treated anyhow in a pre-entry or teacher-upgrading course in the subject, whatever approach or programme is followed? To which extent and to what depth should these elements be treated?

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[*] S/1 - S/4 to be held in separate subject groups.

PLACE: Conference Room of the National Curriculum Development Centre
(4 and 5 December 1981)

Friday, 4 December 1981.

09.00 - 11.00 a.m. S/5 Review of subject discussions.

Each of the subject groups reports on the discussions held in the previous sessions S/1 - S/4.

POLICY DISCUSSIONS

02.30 - 05.00 p.m. P/1 How to improve secondary science education?

The following ways could be considered:

- Teachers' training, either in-service, or pre-service (increasing inputs into science teacher programmes).
- Curriculum development
- Developing teaching materials, worksheets, experimental set-ups, etc.

On which of the above issues should the FUA co-operation programme focus?

Saturday, 5 December 1981.

09.00 - 11.00 a.m. P/2 Defining the target group

- Should a pre-entry science programme aim at university entrants and equally/more/less at entrants into other tertiary science-based educational programmes?
- Is there a need for streaming the programme considering the various target groups; at what stage of the programme could streaming be done?
- Should a pre-entry science programme leave the top students in science of the secondary school out of the course, allowing them direct entry into the university/other programmes?

11.00 a.m. - 12.30 p.m. P/3 Methods and problems of selection

- How to trace potentially able science students?
- How to combine test scores and teachers' ranking in the selection procedure?
- Should the group of students considered for selection be limited to a particular category e.g. only students who have taken Mathematics and at least 2 separate science subjects or Physical Science or General Science as subjects for the Cambridge examination.

03.00 - 04.50 p.m. P/4 Position of the projects in the educational system

- What is the position of a pre-entry science project with respect to the university and to the secondary school system, and what is its impact?
- What is the ideal length of the course?
- Should the project be institutionalized or gradually phased out? What are the problems and terms of localization?

05.00 - 06.30 p.m. P/5 Conclusions and Recommendations.

A.2 STAFFMEMBERS of SCIENCE PRE-ENTRY/TEACHER TRAINING PROJECTS

projects	BIOLOGY	CHEMISTRY	PHYSICS	MATHEMATICS	ENGLISH/STUDY SKILLS	ORGANIZATION/TEAMLEADER	SUPERVISION
UCB-Pre-Entry Science Course (PESC) 1977 —	Dr. W. Boontje 1977-79 Drs. E. Engels 1979- Drs. I.P. Meulenberg 1981 Mevr.Ir. J.C. van Woudt 1982- W. Benthem* 1982 Miss. B.S. Motshume* 1981-	Drs. G. de Jager 1977-82 I.P. Meulenberg* 1980 Drs. I.P. Meulenberg 1981 C. Booy* 1981 Mevr.Ir. J.C. van Woudt 1982- Drs. I.P. Meulenberg 1982- W. Benthem* 1982	Dr. G.D. Thijs 1977-81 I.P. Meulenberg* 1980 Ir. J. Andringa 1981- P. Hoogeveld* 1981 R. de Groot* 1982	Boontje/de Jager/Thijs 1977-78 E. Hammen* 1978 P. v/d Swaart* 1978 O. de Ridder* 1979 Prof. J. Whitley 1979-81 Mevr. W. Schavemaker* 1980 Drs. G. Bruinooge 1981- Drs. C. Smit 1982-	Mevr.Drs. T. de Jager 1977 Miss B. Aspegren (MA) 1978-81 Miss H. Hennessy (MA) 1981- D.M. Allison (MA) 1982-	Dr. G.D. Thijs 1977-80 Drs. G. de Jager 1981- Ir.J. Andringa 1982-	Dr. P. Born 1977- Prof.Dr. P.H. Makhurane 1977-81 Prof.Dr. R. Hartland-Rowe 1981-
UCS-Science Pre-Entry Course (SPEC) 1978 —	Dr. C. Stoll 1978-81 S. Mabuza* 1979-80 R. El-Baradi* 1979 J. van Velzen* 1981 Drs. W. Peek 1981- Miss. M.Saulus* 1980-	Drs. J. Bregman 1978-81 S. Mabuza* 1979-80 R. El-Baradi* 1979 M. Kroon* 1980 Drs. J. van Putten 1982- P. Haring* 1982	Ir. G.J. Schuytemaker 1978-82 D. Dlamini* 1979-80 Mrs. R. Ward (MSc) 1981- Drs. W. Haeck 1982-	Dr. B. Barton 1978 D. Mthethwa (MSc) 1979- H. Hofstraat* 1979 G. de Jong* 1980 H. van der Zant* 1981 E. Kuyk* 1982	Mrs. J. Martin (MA) 1978 Miss B. Moolenaar (MA) 1979-	Dr. C. Stoll 1978-80 Drs. J. Bregman 1980-81 Drs. W. Peek 1981-	Dr. J. Bulthuis 1978- Prof.Dr. L.P. Makhubu 1978-80 Dr. C. Schmidt 1981-
UCS-Science Teacher Upgrading (STU) 1979 —	SPEC-staff +	Ir. F. Lubben 1981-	Ir. F. Lubben 1979-80	Ir. F. Lubben 1980-		Drs. J. Bregman 1979 Ir. F. Lubben 1980-	Dr. J. Bulthuis 1979- Mrs. E. Putsoa (MA) 1979-
NUL-Accelerated Mathematics and Science Teacher Improvement Project (AMSTIP) 1980 —	Mevr.Drs. H. Kapteyn 1980 Mrs. A.M. Setai (MSc) 1981-	Ir. P. Merkus 1980 Dr. W. de Wolf 1981	Ir. P. Merkus 1980-	Dr. P.G. Doucet 1980 Dr. R. Zepp 1981		Ir. P. Merkus 1980- Mrs. A.M. Setai (MSc) 1981-	Prof.Dr. H.H. Boer 1980- P.A. Whittle (MPhil) 1980- Dr. P.E. Khabele
NUL-Lesotho Science Pre-Entry Course (LESPEC) 1981 —	L. de Feiter* 1981/82 Mrs. F.A.Sokiri (MSc) 1982-	Ir. A.H. Wevers 1982- F. Postma* 1982	Dr. W. Boontje 1981- L. Meedorp* 1982	Ir. R. Vogt 1982-	Mrs. R.M. Lynn (MA) 1982-	Dr. W. Boontje 1981-	Prof.Dr. H.H. Boer 1981- A.L. Williams (MPhil) 1981-

GDT. January 1982

*teaching assistants (BSc)

27

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A.3

LIST OF PARTICIPANTS OF THE
INTERUNIVERSITY WORKSHOP ON SCIENCE EDUCATION IN SOUTHERN AFRICA
MASERU - LESOTHO, 2 - 5 DECEMBER 1981

NUL-LESPEC

1. Dr. W. Boontje, lecturer Physics, team-leader LESPEC
2. Mr. L. de Feiter, assistant lecturer Biology
3. Mrs. H.M. Lynn, lecturer English/Study Skills
4. Mr. F. Postma, assistant lecturer Chemistry
5. Mrs. F.A. Sokiri, lecturer Biology
6. Mr. L. Wesdorp, assistant lecturer Physics
7. Mr. A.L. Williams, project supervisor NUL-LESPEC

NUL-AMSTIP

8. Dr. P.E. Khabele, project supervisor NUL-AMSTIP
9. Ir. P. Merkus, director AMSTIP
10. Mrs. A.M. Setai, coordinator AMSTIP

NUL

11. Prof. V.M. Bam, Institute of Education
12. Dr. J. Irina, Dean Faculty of Science
13. Mr. T. Lynn, Department of English
14. Mr. P. Potts, Department of English
15. Mr. R.W. Sayers, Department of Mathematics
16. Mr. E.M. Sebatane, Institute of Education
17. Mr. L. Sylvester, Department of English

UCB-PESC

18. Ir. J. Andringa, lecturer Physics
19. Drs. G. Bruinooge, lecturer Mathematics
20. Drs. E. Engels, lecturer Biology
21. Prof.dr. R.C.B. Hartland-Rowe, Dean Faculty of Science UCB, project supervisor UCB-PES
22. Drs. G. de Jager, team-leader PESC
23. Drs. I.P. Meulenberg, lecturer Chemistry
24. Miss B.S. Motshome, staff development fellow Biology

UCS-SPEC/STU

25. Ir. F. Lubben, coordinator STU
26. Prof.dr. L.P. Makhubu, Deputy Rector UCS, ex project supervisor UCS-SPEC
27. Drs. N. Peek, lecturer Biology, team-leader SPEC
28. Miss M. Saulus, assistant lecturer Biology
29. Ir. G.J. Schuytemaker, lecturer Physics

FUA

30. Prof.dr. H.H. Boer, project supervisor FUA-LESPEC/AMSTIP
31. Dr. J. Bulthuis, project supervisor FUA-SPEC/STU
32. Dr. G.H. Dulfer, Department for International Relations FUA
33. Dr. G.D. Thijs, coordinator working group 'Basic Science Projects' FUA

NUFFIC

34. Dr. G.J.C. van der Horst, deputy director NUFFIC

Interuniversity Workshop on Science Education in Southern Africa

COMPOSITION OF SUBJECTGROUPS FOR SESSIONS S/1 - S/4

Biology

1. Prof.dr. H.H. Boer
2. Drs. E. Engels
3. Mr. L. de Feiter
4. Prof.dr. R.C.B. Hartland-Rowe
5. Miss B.S. Motshome
6. Drs. N. Peek (reporting)
7. Mrs. F.A. Sokiri
8. Miss M. Saulus

Chemistry

1. Dr. J. Bulthuis (reporting)
2. Drs. G. de Jager
3. Prof.dr. L.P. Makhubu
4. Drs. I.P. Meulenberg
5. Mr. F. Postma

English/Study Skills

1. Mrs. H.M. Lynn (reporting)
2. Mr. T. Lynn
3. Mr. P. Potts
4. Mr. L. Sylvester

Mathematics

1. Drs. G. Bruinooge (reporting)
2. Mr. R.W. Sayers
3. Mr. A.L. Williams

Physics

1. Ir. J. Andringa
2. Dr. W. Boontje
3. Ir. G.J. Schuytemaker (reporting)
4. Dr. G.D. Thijs
5. Mr. L. Wesdorp

Teacher Training

1. Dr. G.H. Dulfer
2. Dr. G.J.C. van der Horst
3. Dr. P.E. Khabele
4. Ir. F. Lubben (reporting)
5. Ir. P. Merkus
6. Mrs. A.M. Setai

CHAIRPERSONS OF SESSIONS S/5 and P/1 - P/4

S/5 Review of subject discussions - Prof.dr. L.P. Makhubu
P/1 'How to improve secondary education' - Dr. P.E. Khabele
P/2 'Defining the target group' - Mr. A.L. Williams
P/3 'Methods and Problems of selection' - Mr. A.L. Williams
P/4 'Position of the projects in the educational system'- Prof.dr. R.C.B. Hartland-Rowe
P/5 Conclusions and recommendations - Prof.dr. L.P. Makhubu

LIST OF ABBREVIATIONS USED

AMSTIP	Accelerated Mathematics and Science Teacher Improvement
BSP	Basic Science Projects
BSc	Bachelor of Science
B.Sc.Ed.	Bachelor in Science Education
CCE	Concurrent Certificate in Education
COSC	Cambridge Overseas School Certificate
Dip.Ed.Sc.	Diploma in Science Education
DSE	Diploma in Secondary Education
EMES	Educational Measurement and Evaluation in Science
FOE	Faculty of Education
FOS	Faculty of Science
FUA	Free University Amsterdam
IHS	Institute of Health Sciences
JC	Junior Certificate
LAC	Lesotho Agricultural College
LESPEC	Lesotho Science Pre-Entry Course
LP	Lerotholi Polytechnic
MC	Multiple Choice
NTTC	National Teacher Training College
NUFFIC	Netherlands Universities Foundation for International Cooperation
NUL	National University of Lesotho
PESC	Pre-Entry Science Course
PTC	Primary Teacher Certificate
SCOT	Swaziland College of Technology
SPEC	Science Pre-Entry Course
STC	Secondary Teacher Certificate
STU	Science Teachers Upgrading
UCB	University College of Botswana
UCS	University College of Swaziland
WPTTC	William Pitcher Teacher Training College

LIST OF POSITION PAPERS

S/1 – Interrelation with other subjects of the course

PP1 Biology PESC, E. Engels Page 28
PP2 Chemistry PESC, G. de Jager and I.P. Meulenberg 30
PP3 Mathematics PESC, G. Bruinooge 32
PP4 Physics PESC, J. Andringa 33
PP5 Interrelation between the subjects, SPEC/STU team 34

S/2 – Programmed instruction and open labs/teaching approaches

PP6 Biology PESC, E. Engels 36
PP7 Chemistry PESC, G. de Jager and I.P. Meulenberg 38
PP8 Mathematics PESC, G. Bruinooge 41
PP9 Physics PESC, J. Andringa 43
PP10 'Spoonfeeding or open lab', SPEC/STU team 44

S/3 – Streaming within one subject

PP11 Biology PESC, E. Engels 45
PP12 Chemistry PESC, G. de Jager and I.P. Meulenberg 48
PP13 Mathematics PESC, G. Bruinooge 52
PP14 Physics PESC, J. Andringa 54
PP15 'Streaming within a subject', SPEC/STU team 55

S/4 – Educational objectives

PP16 Chemistry PESC, G. de Jager and I.P. Meulenberg 56
PP17 Mathematics PESC, G. Bruinooge 58
PP18 Physics PESC, J. Andringa 60

P/1 – How to improve secondary education

PP19 'Some notes on science education in Lesotho', P. Merkus 61
PP20 PESC, G. de Jager 75
PP21 SPEC/STU team 77
PP22 'Considering three year high school education', from a speech of M.J. Nsibande 82
PP23 'Recommendations based on experiences in SPEC/STU (1978-1981)', C. Stoll 83

P/2 – Defining the target group

PP24 'Present position of LESPEC', W. Boontje 84
PP25 'Comparison between PESC subgroup and total class performance in FOS/NUL, A.L. Williams 85
PP26 PESC, G. de Jager 86
PP27 SPEC/STU team 88
PP28 'Direct Entry', Prof.N.O.H. Setidisho 89
PP29 'A system of programme quotas', Prof. N.O.H. Setidisho 91

P/3 — Methods and problems of selection

PP30 'Selection procedure LESPEC 1982', W. Boontje Page 93
PP31 PESC team 96
PP32 SPEC/STU team 101
PP33 'Selection in education in Southern Africa', Prof. P.J.D. Drenth 102
PP34 'Selection procedure', Prof. N.O.H. Setidisho 111

P/4 — Position of the projects in the educational system

PP35 PESC team 113
PP36 SPEC and STU in the educational system, Prof. L.P. Makhubu 115
PP37 STU project, Mrs. B. Putsoa 117
PP38 SPEC team 122
PP39 'Need for improvement of Post School Certificate Training', Prof. N.O.H. Setidisho 124

POSITION PAPERS

REGIONAL MEETING LESOTHO. 2-5 December 1981.
from Ernst Engels;PESC-Biology,Botswana.

The Basics of a Biology course in the Bolesua countries.

Introduction

The experiences in PESC-Biology over the past three years, in particular in the last course,with the increased number of students,and the evaluation of the Biology courses by the FUA Department of Biology education,provide recommendations for a Biology programme in the Bolesua countries.

The recommendations outline:

1.The startingpoint of a biology course.
2.Structure of a course.
3.Methods of instruction.

Startingpoints for a Biologycourse.

1.Less emphasis on mere memorisation of facts and more emphasis on the development of concepts.
2.More references to African flora and fauna and situations as opposed to references that occur only in Europe and America.
3.The learning process of abstract concepts should be based on practical experiences.
4.Communication possibilities within a group of mixed ability should be stimulated rather than reduced.

Structure of a course.

This has been described in another paper (See S3). Summary: Per week,per group: 3 periods of 100 min.A minimum of instruction, maximum of selfactivity.The instructor activates groups of mixed ability to coöperate,but is available to help weaker students. Instructionperiods of over 30 min.have to be avoided.Students have to hand in assignment papers at the end of each week.These will cover the core of a course.A free band period in all subjects will cater for weakness in a particular subject.

Methods of Instruction.

Biology,an introduction to life (Nason & Goldstein) has been used in Botswana and is still in use in Swaziland.(It seems to be out of print right now). This American textbook has some advantages over others but is not written for the African situation.On top of that there are some more disadvantages.This is one of the reasons

why PESC-Botswana started with "Home made"lecturenotes,which in fact are a compilation of American and British textbooks,completed with own material.Due to reproduction methods the make up is not very attractive,how juicy one tries to make the lay out.
A big advantage is that one can design a text completely to the course,including local references.
A recent bookreview however (available from PESC-Gaboro Botswana) has identified quite an appropriate textbook,written by thechief examiner in Biology and the secretary for biological sciences to the University of Cambridge Local Examinations Syndicate,(setting COSC exams):
R.Soper and S.Tyrell Smith:Biology,an integrated approach.
For Tropical schools.
The book is designed for O'level candidates,but goes in a number of units beyond it.The approach is very experimental and therefore is perfectly taylored to be used in a course as proposed.
Still it is felt that additional handouts have to be produced,but to a limited extend.

Ernst Engels

REGIONAL F.U.A. BASIC SCIENCE MEETING

DECEMBER 1981

S/1 : CHEMISTRY

INTERRELATION WITH OTHER SUBJECTS OF THE COURSE

(Gerrit de Jager and Sjaak Meulenberg)

1. Introduction

There are three levels of intensity of integration, viz.:

(i) coordination: different subjects taught simultaneously, but coordination between subjects takes place;

(ii) combination : during certain units two or more subjects are combined under one heading, dealing with air, energy, water, etc.;

(iii) amalgamation: during certain units two or more subjects deal with one concept, process, etc.

The choice of level is influenced by the following factors:

(i) demands on the curriculum by the consumers (e.g. Faculty of Science);

(ii) background of the students (level as well as secondary school approach).

2. The Third Level

We are of the opinion that the third level of integration is not feasible in a pre-entry course, because it would lead to very speculative contents; Particular concepts are dealt with at very different levels in the different subjects, e.g. 'equilibrium' is not dealt with in depth in chemistry, but has a quite different meaning in biology and has a quantitative definition in physics. This approach may be useful at a lower level, and for a course which extends itself over a longer period than 5 months.

3. The Second Level

The second level of integration may be achieved in a pre-entry course. It is difficult however to imagine common areas which could cover the whole course. Topics like water, soil and energy appear in all basic sciences, but they all fit in different parts of the subject frame-work. For example, in chemistry it is not possible to deal with energy in a quantitative way without having dealt with the mole-concept, but in physics it follows after a few weeks of mechanics (usually in the beginning of the course). In biology the energy cycle is normally dealt with at the end of course at a rather sophisticated level.

If you don't want a shallow content, the combination will have to take place at an advanced stage of the course, so that the students can put their knoledge to good use. However, the approach will be examplary of character and will not be taken very seriously by the students.

4. The First Level

Far more important is the first level of integration. It is possible to build on knowledge, insights, etc. acquired in other subjects. For example (relating to chemistry):

(1) Biology could make use of soil-classifications made in chemistry.

(2) Chemistry can make use of energy and electricity topics taught in physics.

(3) Certain laboratory skills taught in chemistry are of use in biology and physics.

It is not sufficient to refer the students in passing to the relevant sectors of the student text of other subjects, but one should make an extensive use of each other's material.

5. Conclusion

In our opinion efforts should be made to reach an optimal level of integration at the first level. In addition, one could use one or two weeks during the course to deal with a topic in a multidisciplinary way. This should be done at an advanced stage of the course. Such an 'interval' could be used at the same time to comfront the students with the industrial use of science by visiting laboratories of private companies and government

As an added note we would like to stress that separate lectures in the history/philosophy of science could strengthen the believe of students that this area does not belong to their curriculum. In our opinion it is better to avoid an a historical approach when introducing new concepts and students should if possible be exposed to the links between science and society as part of their curriculum.

GdJ/fjm

REGIONAL MEETING PESC, SPEC-STU, AMSTIP, LESPEC/EMES

Subject Paper 1: Interrelation of Mathematics With Other Subjects In PESC.

The Mathematics course in PESC is aimed at "levelling out" and "up-grading" of the mathematical skills of the students.

The main objectives are:

1. To improve basic computational skills.
2. To develop competency in those areas of Mathematics needed in support of the Science programme at UCB.
3. To develop competency in those areas of Mathematics needed in support of the Science subjects in PESC.
4. To develop competency in the use of pocket scientific calculators.
5. To minimize compartmentalization of learning and to provide links between the various kinds of mathematics.
6. To eliminate rote learning methods.
7. To develop an aggressive attitude to problem solving.
8. To provide students with some insight into the basic structure of Mathematics.

In the objectives 1, 3, 4 and 7 we find the relations with the Science-subjects in PESC.

(1) Most students are quite weak in arithmetic and basic algebra.

In the first two units a lot of attention is spent on these areas. The students benefit from this in the Science-subjects

(3) The mathematical skills needed in the Science-subjects should be covered by Mathematics before they are needed by the Science subjects. To accomplish this coordination between the Science programmes and the Mathematics programme is needed.

(4) In the first two weeks of unit 1 efficient use of the scientific calculator is taught. The students benefit from these skills in the other Science-subjects.

(7) At the start of the course a large a large group of students is"afraid" of problems. They don't know how to tackle them. By developing an aggressive attitude to problem solving the students will lose this fear and will benefit not only in Mathematics but also in the Science-subjects.

Apart from the coordination mentioned above some more is needed:

1. There should be uniformity in notation to avoid confusion.
2. In all Science-subjects there is a discussion on measurements, accuracy and approximate numbers. The approach should be uniform and Mathematics could provide the mathematical background.
3. The Science teachers should notify the Maths teachers of noted gaps in knowledge or skills in Mathematics, so that this can be rectified.

REGIONAL MEETING IN LESOTHO

View Points on S/1-S/4
(PHYSICS)

S1 During the 20 teaching weeks Physics concentrates on mechanics and electricity. Minor parts of the course are energy, heat, waves, optics and magnetism.

Most of the material offered to the students is covered in the secondary school - Physics and Mathematics form the background for the Physics in PESC. Many of the students did Physical Science in which Chemistry is combined with Physics, although taught separately. So during the secondary school students might benefit from the interrelation with other subjects and this continues to a certain extend in PESC and can even be expanded.

Since PESC is a rather concise programme only a few periods are spent to excursion, visit of Gab. Dam, physics for fun. One might think of expanding these activities, e.g.

- for each subject at least one excursion to an area of interest the students might work later;
- one evening (once a week?) for fun and educational activities photography, playing chess, electronics, computer science, etc.)

However, the main feature of the course is the science teaching - concentrated on the application of the theory. Some common fields within the subjects can be found like:

(a) using simple geometry in measurements (M) (P)

(b) using optional principles in photographic processes (P)(C)

(c) treatment of errors, concersion of units, significant figures, (M)(B)(C)(P)
(d) reading of instruments (C) (P)
(e) drawing of graphs (B) (C) (P)
(f) the calculator, once introduced by (M) is used in all science subjects

(g) study skills is quite useful, the way students learn, use the library, etc.

Two evenings are spent to inform the students about their career designation (March/April). This is of direct importance to the students, who opt to change their mind about future career when arriving at campus.

5. Interrelation with other subjects (SPEC/STU team)

After 3 years teaching in SPEC the feeling is, that more interrelation between the subjects is desirable, but practically not easy to achieve without losing somewhre else.

Advantage of interrelation:

- Contradiction can be avoided in e.g. units, symbols etc, because interrelation implies knowledge of each others programs.
- Subjects falling between two syllabi are not neglected
- Subjects can provide base for other subjects. (Gas laws must be taught first in Physics, before they are needed in Chemistry)
- The students see the relation between the different sciences.

Disadvantages of interrelation

- It can spoil the logical upbuilding of the topics of a subject and "artificial" interrelation can lead to muddle and waste of time. (Do not force interrelation for the sake of interrelation)

Recommendations to improve the interrelation:

- Read each others syllabus and material produced (essential)
- For application-questions of a concept the lecturers can ask other subject lecturers for applications other than in their own field
- Reading/Studyskills offered in cooperation with the sciences periods to the students, mainly dealing with exercising general skills like note-taking, graph drawing and reading, drawing equipment etc.
- In the first two SPEC's we offered a waterweek to the students, dealing with all different aspects of water, which certainly improved the interrelation.

  Last SPEC this week was changed into an applied science week with more emphasize on applications of science than on interrelation. However the waterpurification system of Manzini has chemical as well as biological aspects and the Edwaleni hydro-electric power scheme showed some maths applied in Physics.
- Choose topics for the general lecturers which improve interrelation
- In planning a former SPEC once the idea was proposed to spend 1 afternoon per week in solving practical problems about situations in Swaziland with aspects of the different sciences in these problems

PP5

Appendix

Interrelation between Geography and the other subjects in the SPEC course

by Dr. Schmidt, head of the Geography department.

In Swaziland, one way of integrating the material in SPEC is being followed. It involves a limited number of lectures by members of the Department of Geography, which are organised around major themes (e.g. , aspects of interface studies, the riverbasin, natural resources and remote sensing). Each lecture draws upon material, which has been covered in various courses over a period of between one month and six weeks. Such lectures are intended to serve two purposes:

1. the integration and application of primary concepts and facts from the different SPEC courses
2. students are introduced to basic concepts applicable to modern Geography

In addition , it is suggested that such an approach gives students an appreciation of both, the integrated nature of science and the application of the scientific method to the explanation of specific problems facing this country (e.g. erosion, agriculture development, conservation of natural resources).

Clearly it is assumed that such an approach will also give students a better understanding of how science relates to the 'real world' outside the laboratory, and how science relates to issues of concern to the society at large. The approach is also consistent with that used during the SPEC "water-week"

It should be stressed that such an approach does not require a reduction in the teaching time devoted to Biology, Chemistry, English, Mathematics and Physics: indeed, to do so, would be counter-productive .

November 1981

REGIONAL MEETING LESOTHO 2-5 DECEMBER 1981

S/2 Discussion paper

From Ernst Engels (PESC - Biology)

OPEN LABS.

The main means of instruction for the practicals in PESC is the programmed instruction. Step by step students are guided trhough a number of operations at the end of which they have performed an "experiment".

After having finished the operations they are asked questions about ~~to~~ the experiment in the analysis, meant to test their conception of what they have actually carried out. This analysis is corrected and marked and in a post lab discussion the general misconceptions can be clarified. With a set of well prepared, programmed instructions the teacher can in principle make himself nearly redundant. The students gain quite some skills and infact, within the set-up of the PESC due to the student/teacher ratio (±20:1), this is the only possible way to manage running a practical.

During the labs the students increase their technical skills considerably for example handling the microscope. However, it was felt that the development of research skills, cognitive skills and skills in report-writing was negleted.

Therefore Open Labs were introduced in PESC-Biology 1980.

Open Labs, practicals which did not have programmed instruction, were conceived to encourage the development of skills not readily acquired in highly structured programmed experiments. The following special objectives were set for the Open Labs. Students should learn:

I. Research Skills:

a. to recognise and formulate problems;

b. to construct a hypothesis;
c. to make predictions, based on a hypothesis;
d. to make observations, to develop experiments and to carry them out;
e. to interpret results and to draw conclusions.

II. Laboratory Skills, and Cognitive Abilities:

To observe, to measure, to classify, to register, to structure, to take samples, to control, to compose graphs and tables.

III. Report-writing Skills

a. to learn in detail how to set up a report.

In each unit one Open Lab was introduced. Since students entering PESC may have had little or no experience in conducting scientific experiments, guidance was offered by at least 2 instructors per open lab.

Additional time following the lab, was given for writing a report on the experiment. Each report was marked in detail and corrections were given, with suggestions for improvement.

The objectives set for the open labs were met successfully as is shown in the Appendix 36 of the Second Report of PESC-1980.

The Open Labs approach continue as part of PESC in Botswana.

Ernst Engels
PRE-ENTRY SCIENCE COURSE.

10th November, 1981
GABORONE.

REGIONAL F.U.A. BASIC SCIENCE MEETING DECEMBER 1981

S/2 Chemistry

Programmed Instructions and Open Labs/Teaching Approaches

(Gerrit de Jager and Sjaak Meulenberg)

1. Intorudction

The problem is quite well defined by Bloom (1956) p.167 "Often criticism is directed against the over-use of objective-type examinations on the grounds that they do not force the student to produce original ideas or to organize them. Whether or not this argument is defensible is a matter to be decided by further study; in any case, however, lack of appropriate practice must surely account for many shortcomings in the development of synthesis abilities". We believe further that a discussion in terms of'cookery-book'approach versus 'open-lab' approach will not provide useful results, and we propose to have a discussion that centers on the nature of the specific educational objectives that one has in mind for a Pre-Entry Course.

Bloom's taxonomy can provide some structure for this discussion In order to avoid that his becomes very abstract, we give below an illustrative set of educational activities from the PESC 81 syllabus.

2. Application of Bloom's Taxonomy to PESC 81 Chemistry Syllabus 1,00 Knowledge

(References refer to the PESC Chemistry Syllabus)

When the students arrive they are hardly aware of terms like suspension, filtrate, fractional distillation, etc. A series of experiments is needed to familiarize the students with the appropriate terminology (W1.1, 1.2, 1.3).

Concepts like strong/weak , diluted/concentrated acids and alkalis and conventions like the oxidation number (W4.4) take some time. Students have quite some difficulty with interpretation of graphs (W1.7 etc) and classification principles (W1.6).

Most of these elements are necessary for a further study of chemistry and are therefore introduced in the beginning of the course.

2.00 Comprehension

The use of graphical data for use in calculations on lime requirement (P2.5) is a first confrontation with an 'unknown' situation where the comprehension of the student is tested. Later, the student has to sift the warranted data from the unwarranted (3.5) in order to come to a conclusion. Extrapolation of results is only dealt with at the end of the course (5.4) but is then generally understood.

3.00 Application

After receiving a thorough training in mole-calculations the students are given the opportunity to apply their knowledge and to test their comprehension to a completely new situation (P3.6) and 3.7). Rather than giving the name of a product in a reaction words like 'residue' or 'filtrate' are used so that the student has to find his own way.

4.00 Analysis

During the third unit the students are confronted with a with a situation where they have to apply concepts from different sources in order to arrive at a conclusion. It starts with finding the 'wrong' formula of water in P3.5 and it ends with a unit test where the student, basing himself on empirical formulæ which he arrived at earlier, has to use the properties derived from the Periodic Table to come with a single conlusion.

5.00 Synthesis

This starts first at a low level with planning of experiments (P1.7) and at intervals the design of apparatus required to test particular hypotheses (unit 3 especially) and comes than in unit 4 (P4.7) with an "unique communication ", where students have to report to the Public Health Department on the acetic acid content of a vinegar.

6.00 Evaluation

At some stage we tried this out by presenting the students different theories with explain the behaviour of acids and alkalis. This led to quite some confusion among a sizeable number of students and was left out later, although we still present the student with the possibility of having more than one 'theory' for a particular behaviour

A final note on the testing procedure in the Chemistry Syllabus: All unit-tests consist of two parts: one multiple choice question paper and one structured or open-ended question paper.

The first paper mainly relates to the lower level educational objectives, whereas in the second paper the achievement of the higher levels is tested.

The weight of the second paper tends to increase during the course because of the more complex educational objectives.

3. 'Dosage'of Educational Objectives

(1) First of all, the classes indicated above show some hierarchy as Bloom'(1956) p.19 states: Problems requiring knowledge of principles and concepts are correctly answered more frequently than problems requiring both knowledge of the principle and some ability to apply it to new situatinns. Problems requiring analysis and synthesis are more difficult than problems requiring comprehension. Scatter plots of the performances of individuals on one test composed of items at a simple level in the taxonomy against their performances on another test composed of items at a more complex level show that it is more common to find that individuals have low scores on complex problems and high scores on the less complex problems than the reverse"

This does not mean, however, that the more complex educational objectives can not be achieved, but that a careful 'dosage' is necessary. You cannot allow a student to design an experiment if he does not know how to light a Bunsen burner or how to fit glass-tubing in rubber stoppers.

(2) The introduction of more complex educational objectives requires finding 'unique activities', which the students have not met before. In view of the very different background of the students this is not easily achieved, because what might be new and exciting for some students it will be just a revision exercise for others. For example, the discovery approach of the Periodic Table does not work for a great many students, because they already 'know' it.

(3) As already noted in para. 3(1), the introduction of more complex educational objectives tends to lead to more discrimination among the students. When the students are preparing for their COSC exams, undue stress is given to the less complex educational objectives. A sudden 'over-dosis' of more complex educational objectives will not contribute positively to a student's self-confidence.

(4) Activities which imply student-designed experiments require close supervision and intensive follow up. A student: staff ratio of 10: 1 in the minimum required level and the ratio should in fact even be lower. This will put a high demand on manpower.

4. Conclusion

We feel that the use of complex educational objectives should be measured carefully. Especially in the beginning of the course the students should have some time 'to find their feet'.

At a later stage in the course activities with complex educational objectives could be planned when the students have the necessary instruments at their disposal. The quality will depend on the subject-level of the students, (i.e. whether or not the students have sufficient background to tackle such an activity) and the available manpower.

Literature

1. B. S. Bloom (1956) Taxonomy of Educational Objectives Book 1 (Longman, London)
2. Nuffield Chemistry (1967) Handbook for Teachers (Longman, London)
3. Revised Nuffield Chemistry (1975) Teachers' Guide I (Longman, London).

REGIONAL MEETING PESC, SPEC-STU, AMSTIP, LESPEC/EMES

Subject Paper 2: Teaching Approaches in PESC-Mathematics

The Mathematics course in PESC 81 used the following approach:

2 x 2 periods lecture
2 x 2 periods lab
1 x 1 period tutorial
1 x 2 periods test
per week

During the lectures the theory of the new topics was covered and a number of examples were shown. These lectures were given to groups of students, varying in number from 30 up to 90.

In the "labs" the students had to complete worksheets, individual assistance was provided by lecturers and student-assistants.

In the tutorial-period students could ask questions about the topics covered in the previous week or about problems encountered in the labs.

The test periods were used for writing either weekly tests, unittests or achievement tests.

Questions in the weekly tests covered the topics taught in the previous week. These were diagnostic tests for both students and lecturers. These tests did't count in the final evaluation of the students.

Questions in the unit tests covered the topics taught in previous unit. These tests had diagnostic and selectivo functions.

Questions in the achievement tests covered topics taught in all previous units. These tests had diagnostic and selective functions.

Apart from the diagnostic function of the weekly tests, they were used to train the students in test-writing and to "speed up" the students.

Although this appraoch had been proved satisfactory in previous courses, in PESC 81 some shortcomings came to light.

By increasing the number of students from 120 to 150 the heterogeneous character of the group increased. The number of weak students increased absolutely and proportionally.

This forced the Mathematics teachers to focus more on this group of weak students and several of the more sophisticated parts of the syllabus had to be left out.

To stop the top-students from becoming bored additional worksheets were offered to them.

To cope with these problems, in PESC 82 a slightly different approach will be tried out.

Number of lectures remains the same, group size will be limited to 30.
Number of labs remains the same, character of worksheets will change.

The questions will be labeled with 1, 2 or 3 stars. The understanding and ability of solving the one star questions is required for passing PESC-Maths, the 2 and 3 star questions have an increasing difficulty and are optional. Students can only try the 2 and 3 star questions after finishing the 1 star questions. Cooperation between the students in the labs will be stimulated.

Number of tutorials will go to 2. The PESC 82 course showed that 1 tutorial was not enough for coping with the problems of the weak students. The testperiods will be reduced to 1 period per week.

All tests in PESC Mathematics have open questions, this is to increase their diagnostic function.

REGIONAL MEETING IN LESOTHO

View Points on S/1-S/4
(PHYSICS)

S2 The students arriving at PESC have very different backgrounds and therefore the approach to the practicals should be easy. Further the approach has to be the same and easy to be checked for the large amount of students.

This approach might slightly change during the course but one has to keep in mind that during 20 weeks the students should adopt a strict working schedule and this is facilitated by a common and predictable approach from the different subjects. This is one of the reasons the students are provided with a binder at the start of the course with all different aspects as

- worksheets for the practicals
- problem papers
- instructions

within the binder. The student can adopt the routine after one month, including tests after each period of four weeks.

This strict system allows of course for different approaches like programmed instruction or open lab but in all cases the student must feel that (s)he can consult the instructor or go back to a system in order to continue. It is quite possible that "better" students learn quicker and easier through such an open approach than "slow" learners and this aspect is pityful in PESC - where we want to help, to upgrade the weaker students more than the better students.

S/2 SPOONFEEDING OR OPEN LAB. (SPEC/STU team)

Advantages of spoonfeeding.

- students do not have enough content to do open labs.
- they had already plenty of 'discovery' lessons at school and they want science now.
- they 'take in' more content / knowledge of apparatus etc. via guided labs.

Advantages of open labs

- students are forced to think what they are doing instead of automatically following instructions.
- teaches the students 'the scientific method'

The SPEC team tend to prefer the guided lab approach and to stimulat and challenge their creativity, the following activities were introduced :-

- papers/assignments carry extra optional problems
- after school activities like science club/electronics club/ chess club/maths competition.

To do a little more than only spoonfeeding, we require during the last two months in SPEC a more extensive report of their practical:

MULTIPLE CHOICE QUESTIONS OR OPEN QUESTIONS

Multiple choice questions have no merits except easy for the teacher and wide syllabus coverage. They are exceedingly difficult to set well and anyone setting them should ask other members of staff to check for errors. A bank of suitable multiple choice questions is useful, if they are good and suitable ones.

Essay questions are needed because the students show that they know how to formulate a good answer; particularly if the students' first language is not English.

So the feeling of the SPEC team is that using multiple choice questions has to be done very carefully and the general preferences is for using open questions.

REGIONAL MEETING LESOTHO 2-5 DECEMBER 1981

S/3

From Ernst Engels - PESC - Biology

DISCUSSION PAPER ON TEACHING METHODS

Introduction

Based on last course's experience we expect a more heterogenous group of students to enter PESC, in 1983.

This paper aims at summarising possibilities to deal with this differentiated intake within the framework of the PESC structure and ends with a proposal for the Botswana situation. This situation can be transferred to the other projects in the Boleswa countries.

Aim of the Course

The essence of the aim of the course as described in the Plan of Operations pesc 82-86 is .... to improve the standard and enlarge the number of science students who apply for admission to the UCB at Gaborone, such that the number of science graduates from UCB will increase greatly..."

If one bases the educational objectives on this general aim, then the target of our education is the UCB. That would mean that our teaching methods should be directed to potential BSc or DSE students. Interpretation; If we stick to the "restricted" educational objective we do not have to change our teaching methods, because the weaker students do not belong to the targetgroup. We have to keep in mind that PESC is only a six months course and therefore has its limitation. In view of the past experiences one might as well extend the educational objectives, such that also weaker students who will have to leave campus for different science based diploma courses might benefit as much as possible from PESC. ONLY in that case teaching methods should turn into more individualised methods.

Some Methods

1. Streaming
2. Programmed Instruction
3. Conventional methods with individual assignments. e.g. Dalton Montessori
4. Organised homework.

Restrictions, inherent to PESC

Before discussing methods we must keep in mind that PESC contains in itself an important limitation. The course is meant to upgrade students as well as to select students. In some methods the necessity of regular testing clashes with teaching methods.

Discussion of Methods

1. Streaming is nowadays regarded as an unfavourable organisation of teaching, often working out as "self fulfilling prophecies". The weaker students do not benefit from the stimulation influence of the brighter ones.

2. Programmed Instruction is a very appropriate method for heterogenous groups. Students work together, but in their own pace. Practicals are however difficult to organise. A strong differentiation might originate, causing loss of contact between the different groups. Programmes take considerable time to develop. The step by step learning method makes it difficult to survey a subject.

3. Conventional methods combined with individual assignments bears the advantages of both methods. The method is very flexible and can be adapted to the teacher as well as to the local situation. The only prerequisite is that all subjects in a team should decide on an organisational structure, that guarantees each subject the time required.

The methods can be developed such that:

a. Students get more responsibility in their own learning process;
b. the methods are to a certain degree individualised;
c. students can pay more attention to a weak subject;
d. students can be stimulated to help each other.

4. Organised homework

An advantage is that one can force more or less students to work in groups of mixed ability, outside school hours, so that good students might help weaker colleques. The disadvantage is that instead of creating an atmosphere of own responsibility the students get limited. Brighter students might experience the system as a punishment and develop a negative attitude.

Proposal for PESC 1983

1. Organise the Science subjects (Biol. Chem. Physics) in 3 times 2 adjacent hours (100 min.) per group on the timetable.

They are given in labs. In each period of 100 min a limited amount of information is given and simple experiments are carried out by the students. The experiments might either be illustrative or experimental.

This timetabling allows the teacher/instructor a very flexible approach. Long, boring lectures, or should I say, ineffective lectures, are avoided and the students are more actively involved.

Weak students will have more chances to ask questions and students are stimulated to work in groups of mixed ability.

2. At the beginning of each week, each subject hands out the individual assignment papers.

This will contain questions about that week's theory and if needed (the sources of) information to answer the questions.

3. Free band.

Students have to hand in the assignment on the last hour of the last day each week, in each subject.

This hour is fitted in the timetable such that for every subject a teacher is available for assistance, and is called the Free Band. Students are allowed to hand in their assignment at the beginning of the hour if they did not experience any difficulty. Then they proceed to another subject. If they experience difficulties in a subject this system allows for spending more time in that particular subject. The lecturer is available, but supposed to keep a low profile, stimulating bright students to assist the weaker ones.

Notes

1. Instead of 2-2-2 we might think of 1-2-2-1
free band

2. Mathematics should share the free band.

3. Free band, e.g. Friday: group A B C 2-3 pm.
D E F 4-5 pm
or A B 2-3 pm
C D -3-4 pm
D E 4-5 pm

Observation

One might find the amount of theory that can be transferred has to be lowered. In most departments though there is more interest in increasing the students ability than their factual knowledge. Concept learning is not in a disadvantage in my opinion. Of course such a system has to be developed in more detail. It is a must that a team as a whole develops a course, therefore this effort must be seen as a stimulans to start things up.

Ernst Engels.

REGIONAL F.U.A. BASIC SCIENCE MEETING
DECEMBER 1981

S/3 Chemistry

Streaming Within One Subject

(Gerrit de Jager and Sjaak Meulenberg)

1. The case for mixed-ability grouping

There are several arguments in favour of 'un-streaming':

(1) Streaming presumes a beneficial effect for the high-ability students and less frustration for low-ability students. Detailed studies of different modes of operations do not produce much evidence to support this claim. The 'Branbury Enquiry' (David Newbold (1977)) shows that "... in particular there are no marked differences in academic progress between the high-ability children taught in the two systems, although it seems that there may be a re-ranking of their positions in the mixed ability system - perhaps as the result of the greater flexibility for the progress of pupils of varying ability in the heterogeneous system. When stores in each traditional subject were considered slight differences did show up. None streamed students scored high in the sciences - but more of these differences was statistically significant for the sample".

(2) Many people no longer accept the rather simplistic notion of intelligence which was clearly fundamental to the introduction of streaming. There is now no general acceptance of the view that intelligence is a kind of faculty nor that it is one whose efficiency is largely determined by heridity. Such a 'psychometric view' has been largely replaced by a developmental view which sees intelligence more as cognitive growth or intellectual development which is largely influenced by the enviroment. Piaget (1972) even parted with the fixed stages of development and recognizes that they depend very much on organized learning experiences.

(3) The selection for different ability streams presumes the existence of a general ability for all parts of a subject or course. Analysis of the PESC Chemistry results after Unit 2 and the final results (after Unit 5) shows that:

- 26% of the students in the bottom quartile moved to higher quartiles;
- 27% of the students in the top quartile moved to lower quartiles;
- in the two middle quartiles about 28% moved up and 26% moved downwards.

Any kind of streaming would have inhibited this mobility.

(4) Streaming within individual subjects would create unsurmountable time-table problems because the subjects generally do not agree on how to differentiate the students. This is shown by an analysis of the PESC Unit 2 results where this case could only be made for 6 students who were discontinued.

For the remaining 'bottom' 30 students there was agreement in only 10 cases.

(5) The Pre-Entry Courses have been set up to boost the number of suitable science students with the inherent assumption that the grading that the COSC results produce is not altogether reliable. Streaming would have to be done on a smaller set of data than those available at the completion of the course and would create less flexibility in the final evaluation of students (see para (3)). This will inevitably lead to a reduction of 'second chance' possibilities and therefore affect the efficiency of the Pre-Entry Course.

(6) Lastly, the Pre-Entry Course have student bodies that are formed as a result of lengthy selection process. The students attending the course form the 'top' of the high-ability students from the secondary schools. It could be argued that we need to educate them to work with one another. The introduction of further segregation is bound to have an effect on the attitude of the high-ability student that could have a negative effect on his future contribution to the society.

2. Some Methods

2.1 Keller Plan (module system)

This method has many (if not all) of the disadvantages of streaming. It has been tried out in PESC and in UBS but was more or less abandoned. There are two main objections from an administrative point of view:

(1) The method tends to consume a lot of staff-time, because the cheap 'procters' as envisaged by Keller are not readily available,.

(2) Economy of physical facilities forces a limit on the divergence between the top and bottom group (about 6 modules; one module = approx one week of activity). This limit is normally reached half-way through the course and then decisions need to be made on where to compromise.

From a pedagogical point of view many objectives could be raised. To mention a few:

(1) The method tends to increase the differences between the high and low ability student;

(2) Students tend to train for a test and subsequent evaluation of the retention shows poor results;

(3) Once students end up in the 'bottom pit' they do not have enough contact with high-ability students who could help them out with minor problems.

2.2 Additional Tutorials for Low-ability Students

This has been tried out quite intensively in PESC. There is a limit, however, to the number of tutorials that can be given. The low-ability student already needs relatively more time to finish assignments, so that the introduction of special assignments could create an undue amount of pressure.

It turns out that the high-ability students also want to attend tutorials that are specifically intended for the weak students. It is difficult to stop these students from attending tutorials. This problem might be solved by settling individualized assignments (see also para. 2.4)

2.3 Grouping of Students

Present student teacher ratios do not allow for reducing the class size which would be of obvious advantage. However by putting students of mixed ability in small groups together one could achieve the same purpose. In PESC chemistry students are switched around in groups in order to obtain a group of two students one of which has a high and the other a low ability. Students are encouraged to discuss the questions between themselves before producing the answer.

In the coming course we intend to start an experiment with 'study groups'. These will be groups of say six students of mixed ability who during a time-tabled period work together on a particular assignment. Supervision will be minimal, but constant evaluation will be made of the performance of the study group as a whole. Groups will be composed on the basis of sociometric data and academic performance. It is hoped that these groups will create a certain self-reliance and that the high ability students will also take an interest in it.

2.4 Individualizing Content

As with the Keller method one should accept that the 'content' covered differs from student to student. Kelly (1978) writes "Decisions about the content and methods of education can only be taken when we have achieved a clear view of our educational goals .... What matters is not that all children should have a knowledge of the main events of the French Revolution but that they should all be able to think historically and have a developing understanding of the problems that besets man's attempts to learn to live with his fellows; not that they all 'know' Boyle's Law, but that they should all be able to think scientifically and understand how man's enviroment has been and is being developed..."

By setting individualized assignments for groups with students of mixed ability the administrative and most of the pedagogical objections against the Keller plan are dealt with. This will undoubtly necessitate a resource-centred approach where the teacher is the creator and the moderator of the cognitive process.

2.5 Other Methods

Kelly (1978) and Jackson (1970) give further methods that may be used in mixed ability groups of which may be mentioned: team-teaching (using more efficiently the teaching faculties of individual teachers), individual workcards and peer teaching. Most methods tend to individualize the content (but maintaining the objectives) and are more student-centred than teacher-centred.

In the Chemistry component of PESC teaching by the lecturing method is kept to a minimum and students were forced to study resource material by a questionnaire. When the students were asked to evaluate this method at the end of the course we were rather apprehensive. To our surprise, however, the general comment of the students was very positive so that we feel that this method can be amplified and we may consider giving it the individual approach for which it allows.

3. Conclusions

The nature of the Pre-Entry Course would be affected considerably if streaming were introduced because it would obscure the 'second-chance'. Instead, the focus should be on mixed-ability groups, where the content tends to become individualized without separating the students of different ability. Care should be taken not to give too much work to the weaker students.

Litterature

1. B. Jackson (1970) Streaming, an education system in miniature (Routledge & Kegan Paul, London).

2. A. V. Kelly (1978) Mixed-ability grouping, theory and practice (Harper & Row, London).

3. D. Newbold (1977) Ability grouping. The Branbury enquiry (National Foundation for Educational Research, U.K.)

4. J. Piaget (1972) Intellectual evolution from adolescence to adulthood, Human Development 15, pp1-12, 1972.

REGIONAL MEETING PESC, SPEC-STU, AMSTEP, LESPEC/EMES

Subject Paper 3: Streaming Within PESC Mathematics

Although the students in PESC show a large variety in skills and abilities in Mathematics, streaming at a certain stage in the Mathematics course will be difficult and in some cases will have an adverse effect.

In PESC 82, out of the group of students, who had low results in Maths after two units, some had high results in the last three units and thus ended up with reasonably high overall results.

If streaming is introduced in PESC Mathematics, the students i the "weak" stream will become demotivated, for they will realise that their chance of enrollment in a degree programme will be small. We know, from past experience, that all PESC students dream of a degree. The better students in the "top" stream may benefit from the streaming, for a more sophisticated programme will be offered to them, but even here the danger exist, that some students will become demotivated because of the feeling that they have reached "it" and that they are "good enough". As a result they will not see any reason to put more effort into Maths,

How can one solve the problem of teaching a Maths course while maintaining a reasonable level to this mixed ability group of students?

In PESC 82 we will try to solve this problem by:

1. Offering a basic programme to all students. Passing this programme means passing PESC Mathematics.

2. Offering worksheets to all students with questions of three categories:

   The one star category; to pass Mathematics the students should be able to solve these questions, all students should complete the one star questions.

   The two stars category: these questions have a more challenging and more abstract character than the one star category. The students can only try these questions after completing the one star category. The three stars category: the same as the two stars, category, but a bit more difficult.

3. Stimulating cooperation between students. This will be done by dividing the students into groups of six. ,These groups will be a mixture of good and weaker students. The good students should, after completing the one star category questions, provide assistance to the weaker students, if necessary.

4. All test will be at the one star category level.

5. The tutorials will be used as "clinics". Students with problems in certain topics at one star level will be stimulated to attend and to ask questions.

Some examples of "star" questions.

Worksheet PESC 82

1*. A) Draw an Unity Circle.
B) With the help of the unity circle plot the graph of the function $f(x) = \sin x$ for $x \in [0,2\pi]$.
C) Find from the graph the solutionset of the equation $\sin x = \frac{1}{2}$ for $x \in [0,2\pi]$.
D) Confirm this algebraically.
E) Shade in the graph the area where $\sin x \angle \frac{1}{2}$
F) Find the solutionset of $\sin x \angle \frac{1}{2}$ for $x \in [0,2\pi]$.

2*. A) Draw an Unity Circle.
B) Draw the graphs of the functions $f(x)= \sin x$ and $g(x)= \cos x$ for $x \in [0,2\pi]$.
C) Find from the graph the solutionset of $\sin x = \cos x$ for $x \in [0,2\pi]$.

3**. A) Find the solutionset for $x \in R$ of $\sin x = \frac{1}{2}$.
B) Find the solutionset for $x \in R$ of $\sin x \angle \frac{1}{2}$.

4***. Find the solutionset for $x \in R$ of $\cos x = \sin x$.
Find the solutionset for $x \in R$ of $\cos x \angle \sin x$.

REGIONAL MEETING IN LESOTHO

View Points on S/1-S/4
PHYSICS

S/3 The students arriving from secondary schools, having different background at various fields (Physical Science, General Science, separate subjects) have been tested and appear to be quite different in level.

The students develop during the half year of study a career planning often different from their indication on the secondary school. It is mot likely this will continue during the first years at University. This indicates that we only can use the course for general intake to science regardless what course the students applies for later.

A nice system during the course would be that the better students help the weaker students, in order that the slow students learn faster. But most of the time this will not work out because of:

- persons need time to learn, not only attention
- persons do not like (always) to teach others
- the marking system indicates a difference in level, competition element; the better students seeing the weaker students getting a higher mark ceases to feel "better" and looses motivation to teach.
- the better student feels the teaching often as a punishment
- insufficient manpower.

Streaming has many disadvantages, some are mentioned above. Another solution is reducing of class size.

In the course there are a number of weak students. Ideally these weak students can be located - but this is no reality, not always possible. These weak students are distributed over the different groups but not equally.

When raising the total number of students it is quite likely that a more uneven distribution of students occurs.

Example: 10% of 150 students are weak- distributed over the 5 groups as: 2, 3, 5, 4, 1. Then we find clusters of weak students.

This might result in disturbance, lots of inadequate questions, too much attention to the weaker students.

When we raise the number of groups, or reduce the class size then these clusters are less probable.

S3 STREAMING WITHIN A SUBJECT (SPEC/STU team)

Each one of the lecturers in SPEC did have the experience of teaching a wide range of abilities in the course.

Advantages of streaming

-adapted programmes to the different groups.

Disadvantages of streaming

-creation of 'bright' group and 'dull' group

-different final level, but what happens to them afterwards? SPEC is designed to teach something definite.

- practically it is difficult, if not impossible, to combine the streaming with a prop er selection at the end of May. (Streeming of the ten William Pitcher (teacher training) candidates is possible)

The following steps were taken in an attempt to stimulate the bright ones and help the weak ones:-

- Individual programmes (SPEC 1981) (Chemistry and Maths) (partl
- Extra questions for bright ones (Physics SPEC 1981)
- After teaching a concept, set a small test and the ones who passed can leave class, or work on additional (more difficult) assignments. The rest of the students must do extra exercises.
- Remedial teaching for the weak ones, compulsory for students who scored below a certain level in a test.
- Give bright ones extra stimulating lectures, particularly in maths.

If there are examples of individualist programmes which are tested and working, we are happy to see then. To do these individualist programmes, plenty of manpower is required.

REGIONAL F.U.A. BASIC SCIENCE MEETING DECEMBER 1981

S/4 Chemistry

Educational Objectives

(Gerrit de Jager and Sjaak Meulenberg)

1. Introduction

Many points raised in the S/2 paper are also relevant to this subject, although they were mainly of a descriptive character,. Before a discussion of the selection of specific objectives in a chemistry syllabus, it is necessary to define a few general objectives first. These will depend very much on how PESC is conceived. In Botswana there is one tendency to see PESC as a selection instrument for capable science students and another which sees PESC as a 'second chance' type of education.

At present, the second tendency receives more support and this is underscored by the publication of the enrolment data in the PESC Second Report. Among other things these data show that there has been a considerable increase of students with first and second division in COSC who complete Part I Science at UBS. Proponents of the first tendency assume a relative decrease of first and second division students and only a boost from third and possibly fourth division students. Although the contribution from this last category has been significant, especially for the DSE programme, the contribution to the increase is about fifty-fifty from both.

2. General Educational Objectives

Parting from the assumption that PESC is a'second-chance' type of education one of the most important objectives is to reestablish the 'students' self-confidence which in many cases has been destroyed by rote-learning and 'syllabus-pressure' in the schools.

Another important general objective is to 'homogenize' the 'students' level of knowledge of the subject taking into account the rather different backgrounds (general science) physical science/chemistry as COSC subjects).

The other important general objective is of course the preparation of the students for their next stage of education. In most cases, this means that the students need to be prepared for entry to the Faculty of Science.

3. Considerations for the Selection of Specific Objectives

These will depend on the starting level of the students and may differ from place to place. For PESC in Botswana we considered the following factors:

(1) The syllabus should cover the most important topics from the COSC-Cehmistry syllabus, because this is more or less the starting point of the Faculty of Science.

(2) The (new) COSC-Chemistry syllabus 5070 has the following headings:

1. The particulate nature of matter (kinetic-molecular picture from diffusion and dilution exp.)
2. Experimental Techniques (purity, purification, some preparative methods, collecting gases)
3. Classification of matter on the basis of ability to conduct electricity
4. Atoms, elements and compounds (atomic structure and periodic table, bonding on noble gas electronic structures)
5. Mole concept (empirical formulae, molar volume, Faraday, calculations of stoichiometric reacting masses)
6. Electrolysis (fused halides and some solutions)
7. Chemical Reactions (energy changes - not quantitative, speed of reaction, redox reactions)
8. Acids, bases, salts (pH scale as practical measure relative solubilities of oxides, salts as ionic compounds)
9. The periodic table; trends in groups and periods
10. (Descriptive Chemistry)

(3) In the tenth heading there is some organic chemistry but it is based on the products obtainable from crude oil. As a starting point we left out the descriptive part whenever it did not fit in the treatment of any of the fore-going.

(4) Economy of time will force out a few other headings (In PESC Cehmistry: speed of reactions and redox reactions).

(5) An important factor is the organization of the contents which should in our opinion offer an organizing principle which can be used extensively by the students. In chemistry the Periodic Table is an obvious example.

4. Conclusion

We suggest with the provisions made above that a pre-entry course should contain at least:

(1) Experimental Techniques (with reference to purity and purification). This will enable the students to acquaint themselves with the basic chemical terminology such as solution, suspension, melting, filtrate, etc.

(2) Periodic Table (with reference to atomic structure anf trends in properties). This will give a basis for later work on atomic structure and does away with the activity series approach' which produces too many contradictions for the students.

(3) Mole-concept (with reference to empirical formulae and molarity). If possible more applications of this concept should be introduced so that the students by focussing on this concept from different angles get familiar with it.

REGIONAL MEETING PESC, SPEC-STU, AMSTIP, LESPEC/EMES

Subject Paper 4: Educational Objectives in PESC Mathematics

For the main objectives of the Mathematics course, see Subject Paper 1.

The essential concepts and skills will become clear from the syllabus.

Syllabus

The present syllabus was agreed upon after extensive discussions with the Mathematics Department of UCB and subsequent modification over a two-year period.

1.' Pocket Scientific Calculator

Instruction in the efficient use of the calculator. This provides an useful vehicle for the review of some basic algebra and arithmetic methods.

2. Basic Algebra

Review of the basic algebra operations. Special attention to handling operations with negative numbers.

Simplifications of algebraic expressions, the use of brackets, elementary factoring.

3. Factoring

Factoring of both arithmetic and algebraic expressions.

4. Polynomials

Review of the algebra of polynomials, emphasis on multiplication and division. Remainder theorem (without proof) to develop simple techniques of factoring polynomials.. Calculatorprogramme for calculating the values of polynominal functions.

5. Fractions and Rational Expressions

Review of operations with fractions and rational Expressions.

6. Simple Equations

Review of method of solution of simple equations.
Introduction of "row-reduced echelon" method of solving systems of smultaneous equations.

Introduction of simple graphical methods of solution.

7. Quadratic Equations

Graphing of second degree polynomials, axis of symmetry, "zero's" maxima, minima.

Completing the sqaure, methods of solving quadratic equations: "P-Q method", Formula Method.

8. Graphs

Review of correct display of experimental data in graphical form.

Solutions of systems of equations and inequations by graphical methods.

9. Functions

Review of basic set notation: set, element, universe, subset, empty set, union, intersection.

Relations and functions; domain, codomain, range, injection, surjection, bijection, inverse, natural composition.

Representation of functions in box form.

10. Exponents and Exponential Functions

Use of graphical methods to extend notion of exponents to include rational and irrational exponents. Particular emphasis on the functions E_2, E_{10} and E_e.

11. Logarithms

Introduction of logarithmic functions as the inverses of corresponding exponential functions. Establish link with logs and anti-logs as taught in secondary schools.

12. Geometry

Review of basics of plane geometry.

Redemonstration of the most important theorems.

The idea of correct Mathematical proof.

13. Trigonometry

Introduction of the circular functions, with their inverses.

Finding of the function values by calculator and by looking up in tables.

Sine and cosine rule.

Simple trigonometric equations and inequations.

REGIONAL MEETING IN LESOTHO

View Points on S/1-S/4
PHYSICS

S4 Educ. Objectives.

- Performing practicals to underline the theory.
- to understand essential principles in the basic fields of Physics
- to handle basic physics equipment
- to interpret and analyse the results of an experiment
- to express an exp. result in the correct number of sign. figures.

Particular elements:

- significant figures
- working within a given frame work
- be able to translate a text instruction to a programmed instruction (sequence of execution in experiment)
- make use of basic formulae
- interprete graphs
- from measuremants come to a formula
- using correct units.

PP19

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2-5 December, 1981

SOME NOTES ON SCIENCE EDUCATION IN LESOTHO

1. Historical background

1.1 Primary Education

Formal western-type education came to Lesotho with the missionaries of the Paris Evangelical Missionary Society (P.E.M.S.) in the first half of the 19th century. The schools, few in number and low in enrollment, concentrated on the teaching of how to read and write at a very elementary level and the teaching of of simple vocational skills for boys and house crafts for girls. In the second half of that century the R.C. missionaries established themselves in Lesotho after a fruitless effort in Natal. They also build schools. But by the turn of the century enrollment in the P.E.M.S. schools far outnumbered enrollment in R.C. schools. The R.C. Schools saw a rapid expansion in the 1930's and at the moment R.C. schools and L.E.C. Schools (Lesotho Evangelical Church is the successor of the P.E.M.S.) take 40% each of the total primary enrollment, the rest being shared by Anglican schools (13%), government and community schools (1.6%) and other missions.

Enrollment increased from 80000 just after World War II to the present 250,000. Number of schools increased over the same period from 860 to 1100, showing a gradual enlargement of school size. The graph represents the actual and projected enrollment in primary education between 1950 and 2000.

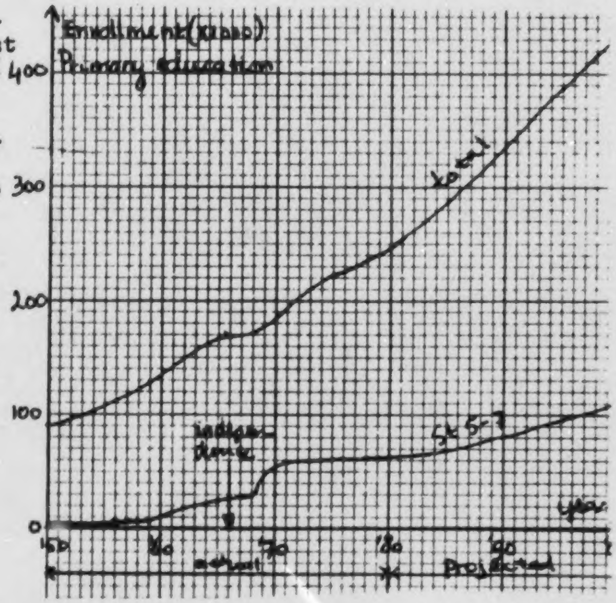


fig.1 Primary School enrollment, 1950-2000

Educational phylosophy in the early days defined the usefullness of schooling in terms of religious purposes and economic necessity. To quote from a 1898-99 colonial report. "To others, who urge higher education of the natives, it may be pointed out that to educate them above labour would be a great mistake. Primarily the labour industry (in S.A.) supplies a dominion want, and secondly it tends to fertilize native territories with cash which is at once diffused for English goods." Missionary work and education went hand in hand. A primary school at a mission station was a powerful instrument to attract and bind converts. Schools were usually set up with very poor financial backing. Teaching was done by the missionary (or his wife), assisted by some promising school leavers. Later a school could receive grants-in-aid from the colonial government if certain standards regarding teacher qualifications were met. By 1948 three quarters of the schools received these grants. Presently all salaries are paid by the government.

1.2 Secondary Education

It is not surprising that secondary education is of comparative recent origin. In 1948 there were four secondary schools of which only one had senior classes. Total enrollment was 870. In 1959 there were 21 secondary schools with an enrollment of 1620, in 1970 there were 39 schools with enrollment of 6030 and in 1979, 96 schools with 21400 pupils enrollment is expected to increase to 60,000 pupils in 2000. A proportion of 20-25% will be in the senior classes. (see graph). Quality of the teachers and teaching facilities have always been much better in secondary schools than in their primary counterparts. Examinations for Junior and senior secondary schools were set in South Africa. In 1961 the senior schools switched from Matric-exam to C.O.S.C. At the moment Lesotho sets its own Junior Certificate examination. Results in the COSC exams have drastically declined from 61% pass in 1970 to 27% pass in 1979. The number of passes, however, increased over the same period from 160 to 380.

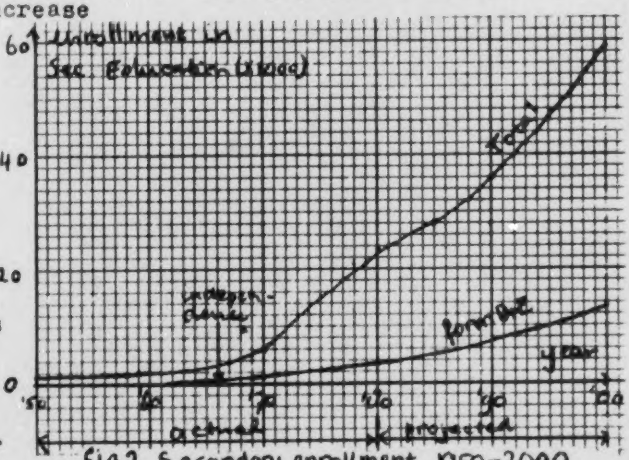


fig 2. Secondary enrollment 1950-2000

At the moment the secondary school system is rapidly expanding through the addition of new schools, the upgrading of junior secondary schools to high schools and the addition of new streams in existing schools.

1.3 Teacher Training

In the past teacher training was done in Colleges governed by the missions. In 1947 there were four colleges which number was increased by 1959 to 7, with a total enrollment of 520. Entry requirement for the 3 year lower primary course was standard VIII and for the 2 year higher primary course Junior Certificate. The University College Pius XII used to run a post school-certificate teacher training course directed at junior high school level. The National Teacher Training College opened in 1975 taking over the training from all these institutions. The colleges became high schools and the university started a degree course in science education. A remarkable concern, expressed in a number of colonial reports, was that the enrollment into teacher training was not limited by supply of applicants or the capacity of the colleges but by the funds available to pay salaries to trained teacher. The same concern appears in a number of recent employment studies: the government might not be able to pay a rapid increasing force of qualified teachers.

1.4 Vocational Schools

Missions have for many years been concerned with vocational training. In the so-called "industrial schools" of the P.E.M.S. boys and girls learned the relevant skills. The Lerotholi Technical Institute was founded after the people of Lesotho, on the unitiative of paramount Chief Lerotholi, contributed money towards its building costs. The colonial government has never been very active in this field. Recently vocational training was boosted by expanding the Lerotholi Poly Technic and other technical institutes and by introducing vocational subjects in a number of high schools.

1.5 University

In the early days Basotho students could study at Fort Hare College in the Cape Province. For this service the colonial government paid £300. per year to the college and was represented at its board of goverrers. In 1958 South Africa terminated this agreement. Also a number of Basotho studied at the Medical School of Natal.

In 1938 the National University of Lesotho started at Roma as the Catholic University College Pius XII. The aim was to provide "African Catholic students with post-matriculation education coupled with religious guidance." The college catered for the whole of Southern Africa. In 1946 it moved to the present site. In 1954 enrollment was 35 of whom 9 were Basotho. From 1954 to 1964 it was an "Associate College" of UNISA. The independent, non-denominational university of Basutoland, Bechuanaland Protectorate and Swaziland (U.B.B.S., later U.B.L. S.) was established in 1964. In 1975 Lesotho pulled out and established the National University of Lesotho. Present enrollment is well over one thousand with 80% local students.

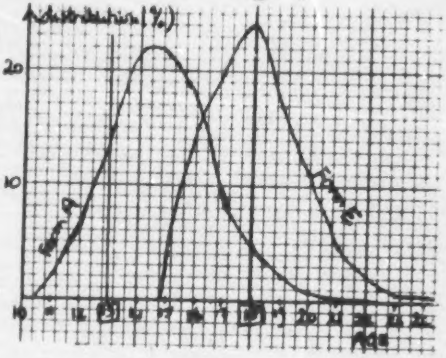
2. Mathematics and Science Education in schools, the present state

2.1. What type of teaching do students need?

Piagetian theory distinguishes four stages in concept development. These stages occur in fixed order. The last two stages, the concrete stage and the formal stage, are important at school age. At the concrete stage children are only able to perform operations with concrete objects and at the formal stage pupils are able to perform operations in hypothetical situations. The progress within a stage and transition from one stage to another is governed, according to Piaget, by four factors: 1, maturation of the personal physique, 2, social transmission within his environment, 3., 3, experience and 4, equilibration. In Lesotho nutritional standards in certain areas, in certain social groups and in certain years are poor which results in a slow physical maturation of our students. Migrant labour disturbs many families with as result that children get less attention from parents. Also at higher primary and secondary level teaching is in English, a language not properly understood by many pupils. These facts make that also social transmission is reduced. Experiences of Basotho children are very often not relevant for mathematics and science We can expect that the average age at which children in Lesotho enter the formal stage will lag many years behind the average age for this transition in urban societies. Research in other African countries has shown average transition ages of 15-17 years. This means that all children at primary school and junior secondary schools and many students in high school one in the concrete stage. Piaget's research has also shown that if children study an unfamiliar topic they tend to go back to the concrete reasoning patterns. Their speed of transition to the formal stage depends on the amount of experience the student has in this transition exercise.

These research findings show that, especially in developing countries, students should learn through "hands on" science and mathematics. The irony is that, especially in developing countries, this is not the case. Because (s)he is unable to assimilate the new concepts the Basotho child, confroted with inadequate teaching, resorts to rote learning, a phenomenon most teachers are very famili-ar with.

Another factor influencing teaching is the large proportion of overage children in schools. Fig. 3 shows the age distribution of pupils in forms A and E in 1979. If a child enters school at six and doesnot repeat then its age in Form A is 13 and inform E is 18 yrs. It can be seen that overage enrollment is especially serious in junior forms. The teacher has to adjust his teaching style such that young pupils are motivated while older pupils do not regard it as childish.



2.2 Primary schools

Science and maths are both taught in primary school and form part of the standard VII examinations. However in many schools both subjects get only "talk and chalk" attention. In many cases, classes are too large (average class size 50 pupils) to do any meaningful practical work. Many schools have no teaching aids for science. On the other hand the syllabuses for maths and science tend to be very ambitious. Usually new syllabuses are discussed with teachers from and tried out in better schools in urban areas. The result is far beyond the capabilities of the rural school pupil and teacher. At the moment the National Curriculum Development Centre conducts a major shake-up of primary syllabuses and produces teaching materials that go with the revised syllabuses. I hope that the new versions are tailored to the capabilities of the majority of the schools. Agriculture has recently been made a compulsory subject in all schools. Implementation of this new policy will start at primary level. A number of attempts are being made to introduce handicrafts skills in primary schools.

English is the teaching medium from Standard IV upwards. But many teachers continue using Sesotho and reading ability when students enter secondary school can be anything up to five years behind similar pupils who have English as their first language. Reading scientific texts or maths problems is seriously restricted by this handicap. Recent research has shown that at the beginning of secondary school pupils perform logic operations better in Sesotho than in English. This is reversed in Form D.

2.3 Secondary Schools

In 1979 the average school size was 220 and the average class size was A:43, B:40, C:36, D:34 and E:30. The pupil/teacher ratio was 23:1, an average teacher taught 18.2 hours per week and an average class was taught 30.8 hours per week (of which 18% by unqualified teachers).

In 1981 100 science/maths teachers were needed in senior classes and 275 in the junior classes. The science/mathematics teaching force was then 230 teachers with a diploma or degree in science education (55 local and 175 expatriate). 120 teachers with a certificate or equivalent (all local) and 110 untrained teachers, a total of 460 teachers. This leads to the conclusion that a sizable proportion of lessons by diploma/degree teachers is at junior level (approx 50-60%), that science teachers teach approx. 20% of their lessons in non-science subjects, that there is a tremendous shortage of local science teachers at junior and senior level. The high number of untrained teachers is due to the unequal distribution of qualified teachers over the schools. They teach mainly in urban schools. The 120 certificate or equivalent teachers include teachers with primary higher certificate plus COSC. This course had little science specialisation and by international standards these teachers are underqualified, there are approx. 40 of such teachers.

A serious short coming of the statistical data on science/mathematics teachers is the non-availability of data for the distribution of these teachers over the subjects mathematics, intergrated science, physical science and biology, both in terms of demand and supply. An unbalance in this, which for instance forces biology teachers to teach mathematics (or reverse), increases the number of unqualified lesson being taught.

The average length of service of local degree science/mathematics teachers in 1978 was 7.3 yrs, reducing (with a steady stock) to 5.8 years in 1979. This suggests an annual attrition rate of ±17% with tendency to increase. Equivalent figures for S.T.C. science/mathematics are 6.8 years and 5.2 years, but this reduction is mainly due to inflow of young teachers, an attrition rate of 5% seems reasonable. In non-science average length of service increased over the same period from 12.2 years to 12.5 years for degree teachers. The high drop out rate from the science/mathematics teaching profession is due to poor teaching conditions and high attraction of outside jobs.

The subjects taught at secondary schools are mathematica (all students), integrated science (LISIP, all students at junior level), physical science (about 45% of students), biology (about 70%) and human and social biology (about 30%), at senior level. In the early 1970's the J.C. syllabus has been revised. Mathematics and integrated science have a modern approach with textbooks specially directed at the region. Integrated science is mainly practicals based with books for back-ground reading. Unfortunately in many schools practicals are rare, mainly due to poor laboratory facilities, large classes, and poor motivation on the part of the teacher. The background reading texts are then used as main text, a situation which, from the educational point of view, has to be deplored. There is a mismatch between the J.C. syllabuses and the COSC syllabuses. The COSC syllabuses tend to be old-fashioned and packed with often irrelevant topics. Especially in Physical Science there is reason for concern. This has resulted in an over loaded form D/E programme. As a result teachers have yet another reason to teach only through "talk and chalk."

The quality of schools tend to be unbalanced. In 1979 the top 7 schools (out of 29) got 51% of the passes in the COSC exam and the bottom 7 schools scored 5% of the passes. In science/mathematics this unbalance is worse: in 1979 the top 7 schools (out of 28) produced 72% of the passes with credit (grade A-C) in Physical Science and 13 schools did not produce a single credit pass. Examination results have gone down over the years. Comparing the 1974 and 1979 passes (grade 1-8 or A-E): Maths 24.8% to 22.3%, Biology 41.9% to 33.4%, Human and Social Biology 65.9% to 64.3%, Physical Science 40.8% to 26.0%.

Science teaching facilities are poor. Schools on average have one laboratory, but many have to do without. In Thaba-Tseka district four schools have to share one laboratory and in Butha-Buthe district 8 schools share 3 laboratories. Many of the laboratories are of very poor quality, without services and with little equipment. If equipment is available then usually in small quantity so that "hands on" science with large classes is very difficult. Under these circumstances teachers are not very practical minded. Together with a certain degree of reluctance from the part of the teachers to organize practicals it is more the rule than the exception that students leave school without having done any practical. I have seen many pieces of apparatus gathering dust or never unpacked since their delivery many years ago.

2.4 Science and Mathematics Teacher Training

Teacher Training is done at NTTC and N.U.L. NTTC awards the Primary Teacher Certificate (P.T.C.), Advanced Primary Teacher Certificate (A.P.T.C.) and the Secondary Teacher Certificate (S.T.C.). S.T.C. specialises in two teaching subjects at junior secondary level. N.U.L. awards the Diploma in Science Education and the Bachelor in Science Education. Dip.Sc.Ed. qualifies to teach one subject at junior and one at senior level. B.Sc.Ed offers two subjects at senior level. Entry qualifications are: PTC: Junior Certificate, A.P.T.C.: COSC + experience, S.T.C.: COSC, Dip.Sc.Ed: S.T.C. or 1st/2nd year fail at NUL, B.Sc.Ed.: COSC. Annual out put for STC:(Sc/M) is 10-15, for Dip.Sc.Ed. is 10-15 and for B.Sc.Ed is 4-7. All programmes produce considerably below output targets figures (S.T.C.(Sc/M): 35/yr, Dip.Sc.Ed. 20/year, B.Sc.Ed.: 35/yr).

NTTC and NUL find it very difficult to fill the required places. Teaching is a very unpopular profession. This is due to historical reasons, until recently poor salaries, poor conditions of services, poor career possibilities, poor housing and poor schools. At the same time science graduates are offered attractive other employment. Also science/maths is regarded as difficult and other teaching subjects have lower failure/dropout rates. The result is that most of the students entering science education are of mediocre academic quality and the institutions have to operate far below capacity. Because we cannot afford in these circumstances a stringent selection procedure during the courses, out put quality drops below the necessary level. Another cause for concern, especially at NUL,is that much of the teaching tends to be traditional in content and style and in general is not a good example for future teachers. I suspect that some of this also applies to NTTC but the situation there seems potentially better.

2.5 Future supply and demand of Science/Mathematics Teachers.

I have tried to work out the demand of science/ mathematics teachers over the next two decades and a few scenarios for the supply of these teachers.

I have assumed the following:

- secondary school enrollment has been taken from a recent manpower study.
- pupil/teacher ratio for junior school 28:1 and for senior school 20:1 resulting in an overall pupil/teacher ratio of 26:1
- 5 out of 14 teachers (36%) are science/mathematics teachers
- requirement for degree/diploma teachers is determined by form D/E enrollment
- the Degree/Diploma group of teachers teach 1/3 of their lessons at junior level (this is for Dip.Sc.Ed. 1/2 of the lessons and for B.Sc.Ed 1/4 of the lessons). This is a rough guesstimate, Degree teachers tend to crowd in the good urban schools with as result that in these schools all junior lessons are taught by degree teachers. Also, if a degree teacher works in a small school he will have to teach many junior classes. My guestimate seems to me on the conservative side.
- Diploma Sc.Ed. output will be for pre-service 10/yr up to 2000 and for inservice 7/yr up to 1985, 10/yr upto 2000.
- Up to 1985 output of S.T.C. (Sc/M) is 15 yr and for B.Sc.Ed /Dep.Sc.Ed. also 15/yr.
- attrition for S.T.C. (M/Sc) teaching force is 5% per year.
- scenario A: S.T.C. (Sc/M) out put remains 15 per year
- scenario B: S.T.C.(Sc/M) output is 30 per year, 1986-2000
- scenario C: S.T.C. (Sc/M) output is 40 per year, 1986-2000
- scenario D: S.T.C. (Sc/M) output is 50 per year, 1986-2000

- Scenario I: B.Sc.Ed/Dip.Sc.Ed output remains 15 per year and attrition rate is 10% per year
- Scenario II: B.Sc.Ed/Dip.Sc.Ed. output is 30 per year, and attrition rate 10% up to 2000
- Scenario III: B.Sc.Ed/Dip.Sc.Ed. output is 30 per year, 1986-2000, and attrition rate is 10% upto 1990 and 5% thereafter.
- Scenario IV: B.Sc.Ed/Dip.Sc.Ed. output is 40 per year, 1986-2000, and attrition rate is 10% upto 2000
- Scenatio V: B.Sc.Ed/Dip.Sc.Ed output is 40 per year, 1986-2000 and attrition rate is 10% upto 1990 and 5% thereafter

The 5% attrition as from 1990 has been included in Scenario II and V because some reports claim that in the future the labour market for science graduates might tighten. I doubt whether this will happen before the year 2000, It will depend on many factors: economic growth, aid inflow, RSA market forces, extension of the educational superstructure (Ministry of Education, N.C.D.C., LESPEC, NUL, NTTC). salary, conditions of service, etc.

The graphs in fig.4 show the demand supply and shortfall/surplus for S.T.C. (Sc/M) and B.Sc.Ed/Dip.Sc.Ed teachers upto 2000.

We can draw the following conclusions:

1. For Junior school the only scenario which solves the problem of shortage of teachers is scenario D (NTTC output 50/yr). In scenaries A and B the shortfall increases and scenario C reduces the sh shortfall only marginally.
2. For Senior School scenario III, IV and V solve the problem but it is doubtfull whether III and V are realistic (see above). In scenario I the problem is contained untill 1988 and then becomes worse. Scenario II (improves the stituation until 1990 but then the shortfall increases again.
3. Unless scenarios D and IV are followed Science Education in schools will have to rely on untrained and expatriate teachers untill far into the 21st century. The experts will fill places in Senior schools and some junior schools, but the majority of the posts in junior schools will be filled by untrained teachers resulting in poor standards.

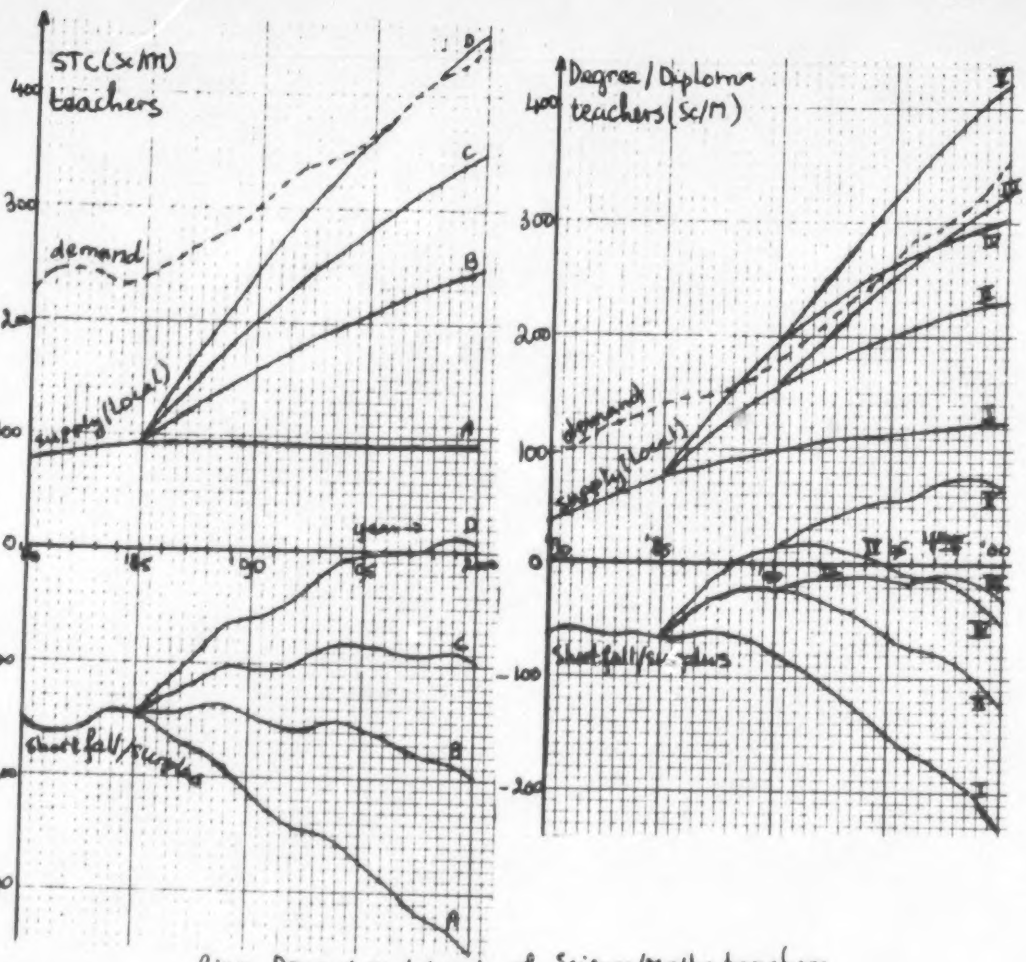


fig 4. Demand and supply of Science/Maths teachers

Remark: The S.T.C. and Dip.Sc.Ed/B.Sc.Ed figures are interdependent. If the Dip.Sc.Ed/B.Sc.Ed. targets are not met the shortfall in STC teachers will increase and visa-versa.

The table in fig. 5 estimates the necessary annual intake for NTTC and NUL assuming that:

- the annual dropout or transfer ratesat NUL is 10%
- the overall drop out or transfer rate for the STC (M/Sc) course is 20%

STC (Sc/M) 1983-2000		Dip.Sc.Ed			B.Sc.Ed 1983-2000		
Scenario A	19	preservice		10	identified in:	yr I	Yr II
B	38	inservice	'80-85	9	Scenario I	8	7
C	50		'86-00	12	" II/III	18	16
D	63				" IV/V	34	30

Fig 5. Estimated intake figures for NTTC/NUL Science Education.

Fig. 5 estimates intake for NTTC and NUL.
In order to follow scenario C or D NTTC has to expand its STC (Sc/M) capacity. In my opinion the Department of Science Education at NUL will be able to handle the increased intake of scenario IV/V. The main problem will be to pursuade students to enroll into Science Education. For NTTC the proposed AMSTIP upgrading course and the LESPEC course will help only partly. To meet the target figures the LESPEC quotum for NTTC should be drastically increased to around 40 upto 1986 and 60 after 1986. For NUL the solution should be found in 30 tied scholarships per year for B.Sc.Ed.

3.0 How to improve Science and Mathematics Education in the future?

Many measures which improve teaching in general will also improve teaching in Science and Mathematics. Amongst necessary improvements are

- improved conditions of services (housing, pension) for teachers.
- improved teaching facilities and decent classrooms
- improvement in school management through training of heads, provision of administrative staff, etc.
- the inspection and guidance of schools should be expanded and improved in quality.
- preferential treatment of rural schools and teachers
- in general the government should win back the trust of the teaching force by promotion of professional conduct, a decent personnel management, urgent programmes for teacher upgrading, etc.

In the field of maths and science in secondary education many measures and reforms are needed. For example the teaching facilities should be improved, this means the building of laboratories and provision of equipment. Because of limited budgets cheap and simple equipment should be produced in schools and in the production unit at the Maths Science Centre. This equipment should be property introduced to teachers at workshops. The LESPEC/AMSTIP project staff could possibly play a role in these workshops. Most schools are very poorly supplied by commercial equipment and chemicals trading firms. The Mathematics Science Centre could act as an agent between schools and these firms. This could be in the form of order processing bulk discount, educational advice, equipment testing, small repairs, etc. The Mathematics Science Centre should be open to teachers on saturday mornings.

There is an urgent need for short in-service courses. This need arises forinstance when schools upgrade to high school and have to introduce COSC subjects, when newly arrived expatriate teachers arrive in the country, when syllabus changes have to be explained to teachers, when teachers have to be introduced to new teaching styles and approaches, etc. LESPECT/AMSTIP staff could be involved.

New syllabuses and textbooks should be produced which are more relevant to the country. Text books should take special note of the language problem. In maths an attempt is made to produce such text books. It is the task of the National Curriculum Development Centre to carry out such an exercise. As the NCDC is presently working at primary level it will take some years before high school reforms will start. Another area of concern is the Lesotho Integrated Science Improvement Project material. This LISIP course has never been properly introduced to teachers and hardly any back up services, like equipment provision and introduction courses, are available. To get the LISIP phylosophy off the ground urgent action is needed.

As far as Science/Mathematics Teacher Training is concerned a plan should be produced for localisation of the teaching force, say by the year 2000. Teacher Training for junior level should get priority. In the short run we can expect an improvement in teaching from the replacement of untrained teachers. But from the replacement of experienced expatriates by inexperienced local teachers we can not expect the

the quality of teaching to improve. This will especially show effect at senior level. In the long run it is essential, in order to improve teaching quality, that localisation takes place and that measures are taken to reduce the attrition rate of Science/mathematics teachers. Also important will be the provision of short post graduate in service courses by NUL and NTTC. In general the services available to teachers should be improved and extended.

The intake quality into the NUL Science Education streams should be improved. It causes considerable concern that the teaching force is expanded with badly motivated and academically mediocre teachers. If a teaching force is to have an input in future curriculum reforms it is essential for the quality of this input that active and intelligent teachers take part. An injection of above average students into Science Education will be an investment into the future. It would also improve the standing of the profession. Government and donor agencies should actively contemplate to give preferential treatment to such students, for instance in the form of free scholarships coupled with a bonding of agreement. NUL (and NTTC) should look into their programmes and device ways of improvement in terms of content more relevant to teachers and teaching methods as good example to teachers.

There is a need for research in Science Education. However many much needed educational reforms can be carried out without elaborate research. The research should be practical. oriented, directed at urgent current problems and solutions. Some fields of research could be: gathering statistical and other data on science education, research in concept development of Basotho children with implication for teaching, research into teacher, pupil and parent acceptance of innovations in curriculum reform, gathering data on man power requirements, etc. Recently the Lesotho Educational Research Association has been founded and a section on Science/Mathematics research should be formed. Its first task should be formulation of priority areas for research.

R. Merkus
AMSTIP

REGIONAL F.U.A. BASIC SCIENCE MEETING DECEMBER 1981

P/1 How To Improve Secondary Science Education?

(PESC - Botswana)

After some informal discussions with officials of Botswana Government on possible contributions in the field of secondary science education the following areas of interest may be defined:

1. Secondary Teacher Training College in Molepolole

This college will possibly start to operate in 1984 and will cater for the teachers needed for the junior secondary schools. It is expected that the J.C. curriculum will be revised to make it more suitable for the rather wide mix of a abilities of the students who will be joining the junior secondary schools in ever greater numbers. For most students, this education will be the last leg of their formal training, so that the curriculum which up to now is focussed on O' level preparation needs revision.

At present Prof. Cammaerts of Rolle's College (Exter) is advising MoE on guidelines of curriculum development in the line of the Botswana National Commission on Education's report Education for Kagisanyo (1977).

Indications are that a far more general teachers will be needed than the present subject based diploma teachers. One could expect perhaps two main specializations one science based and one arts-based. It is unlikely that PESC will be able to produce enough science-based candidates for enrolment into this college (50 to 70 p.a.). On the other hand it will be dificult to find suitable candidates outside the PESC group for enrolment in the science based career. In this connection one could think of a separate pre-entry course for this college.

2. Supply of Science Equipment

The UNESCO has been approached for a consultant on the establishment of a central supply unit for mathematics and science equipment possibly attached to TAPU in Francistown. UNESCO agreed to supply this consultant who is expected mid 1982.

In view of the relatively limited demand for equipment (even for the junior secondary schools)one could think of a regional set-up in the context of SADCC with EDF funds. I understand that regional projects (that includes more than Botswana) of such a nature, although difficult to start would receive a rousing welcome from donors such as EDF.

It would be useful to keep in touch with the UNESCO consultant, especially if Jouke Andringa's work in this field could be used.

3. Curriculum Development in Junior Mathematics and Science

In the coming years concrete steps will have to be taken to start curriculum development in what the MoE refers to as 'applied mathematics'. The new 'Certificate in Mathematics', introduced as an easy alternative to the COSC Mathematics Syllabi, in a step in this direction. This syllabus needs revision and evaluation and the same applies to the Mathematics syllabus for the junior secondary schools. The UNESCO was approached on this matter but no concrete steps were taken.

PP20

There will also be a need to develop a science syllabus for the junior secondary schools.

This could be a useful area for cooperation especially if seen in conjuntion with the teacher training element of para. 1.

9th November, 1981
GABORONE.

G. de Jager
PRE-ENTRY SCIENCE COURSE.

GdeJ/fjm

The SPEC/STU team in Swaziland discussed the points mentioned in the agenda for the Lesotho conference and this paper summarises the the discussion

November 1981

P/1 How to improve the secondary science education ?

-Teacher training was considered as the main bottle neck more than curriculem development or developing materials

During the discussion about the teacher training the following questions raised:

"Why are teachers so often not good teachers and why are the exam results so low ?? "

A list of possible reasons and possible answers was drawn up

1. Lack of motivation/discipline of teachers

   Possible answer:higher salary,higher social status of teaching job,no unexpected transfers,better support Min.,give bonus for teaching in rural areas,more competition for jobs etc.

2. Lack of content knowledge

   Roughly the following distribution of Science/Maths teachers exists in Swaziland: 70 appr.Peace corps + other foreigners
   70 qualified Swazies (W.P. + UCS)
   70 unqualified Swazies(only O'level)

   (N.B. W.P. stands for William Pitcher Teacher Training College which leads teachers up to Junior level,by offering a two year diploama course)

   A proposal how to improve the content of the teachers will be presented in Appendix A of this P/1 paper

3. Low level of primary school leavers

   The primary education faces similar problems as the secondary education.Attention is already paid to primary level.It should be emphasized,that improvement at primary level is even more important than secondary level specially in maths.

4. Huge range of capabilities of students following more or less the same syllabus

   Offering technical education as an alternative to high school education could provide better education to the students.The form III as well as the form V syllabi serve two different aims,preparing for further studies as well as preparing for society the schoolleaver

   N. B. To make somebody a good carpenter you should offer him/her subjects needed for carpenting + general subjects + on the job training and not like the existing system - just add a few periods woodwork to the time table

5. Organisation of the schools is low

   Deputies /Heads of schools should have training in running schools and have at least some years Teaching Experience

6, Teaching methods of the teachers are wrong

   T.T. courses should be more related to the classroom situation. Visits from tutors and/or Ministry could help

7. Teaching environnement disencouraging(big classes,lack equipment etc.

   More money for building new classrooms,equipment etc. ,but also: schools should look better after existing building,benches,equipment

8. Curriculum not suitable for Swazi cultural background

   Better material should be produced,adapted to Swazi/African culture/ circumstances.(Easy to wish,difficult to produce).

   It should be possible to explore the idea to have local syllabi approved by Cambridge

9. English,a foreign language is used as instruction language

   To abolish English seems impossible in the near future.Try to make sure that the English level of the students is up to standard (Heard:if Siswati would be used for instruction,the results will improve a lot)

Swaziland is not the only country with science secondary/high school problems. Countries, longer independent than Swaziland, must also have met these problems and information should be available, how to tackle these problems succesfully

APPENDIX A

Discussion paper on SCIENCE Education and the role of SPEC/STU

In terms of the future of SPEC/STU we have the following existing facts to deal with :

1. The Science Education in Swazi schools is weak and the weakest link in school teaching has to be proved to be the Jun. Sec. Schools (UNESCO report). It is specially this Jun. Sec. School that the Swazi gouvernement intends making compulsory (10 years basic education) . Rapid increase of the number of Jun. Sec. Schoc will have to be taken as a fact.
2. The general aim of the SPEC/STU projects is the improvement of Science/Maths based training in Swaziland, presently implemented by
   (i) increasing the output of Swazi B.Sc.'s to teach in the High sc
   (ii) improving the quality of the trained STC's to teach better in Jun. Sec. Schools
3. The projects are not departments of UCS but due to funding throug an interuniversity body (NUFFIC) the projects are physically base at UCS. W.P. is formally affiliated with and supervised by UCS and all STC certificates carry the Rector's signature
4. Funding of the present STU project is secured till 1985 through [illegible] with the provision that "the long term structure of the Science Teacher Upgrading program is being looked into" . That means that within the proposed budget and within the stated aim 'to improve the quality of Science Teaching in Sec. Schools ' funds could be reallocated .

5. SPEC staff has plenty of expertise and is willing to devote some time outside the period Jan-July to other ways of improving SCience Maths based training, besides the Science Pre Entry approach.
6. The training capacity of Sciece/Maths teachers at WP is presently underused due to lack of trainees. Teacher training for Jun. Sec. Schools by W.P. is considerable cheaper than by UCS

PRESENT activities SPEC/STU in the educational sector

1. Besides the increased intake for SCOTT and IHS, SPEC's main effect is the increased intake for FOS/UCS, sothat the quantity of Sc/M teachers for High Schools is increased to replace expats. Quality of Sc. teaching in High Schools hardly changes herewith (no need seemingly)
2. Admitting ten untrained teachers in preparation of WP-STU training the quantity of Science teachers for Jun. Sec. Sch. is increased moderately by SPEC (To offset the number of possible WP trainees attracted to FOS/UCS by SPEC ?)
3. STU through the Dip. Ed.(Sc) improves the quality of Jun. Sec. School science teachers

POssible future activities of SPEC/STU in the Educational Sector

1. The SPEC project needs to continue to provide quantity for BSc teacher training for High schools to replace expats. The quality of these teachers is looked after by the BSc program itself.
2. The quality of teacher training through W.P. for Jun. Sec. Schools could be improved by policy decisions by WP, FOE and Min. Ed. to intensify the teacher training by way of a major/minor set-up at W.P. In this case the present STU upgrading program will become superfluous. Initiatives are to come from UCS (that is FOE) as supervisor of teacher training content.

Discussions on this has started within FOE. Support for W.P. might be needed in terms of qualified staff and/or equipment.

3. The quantity of Jun Sec. school Sc/M teachers could be increased in several possible ways:
   a) Admit an extra 30 students to the present SPEC courses and keep the intake for BSc year I constant,so that more students are groomed for WP intake after SPEC.Disadvantage:extra staff,labs and boarding facilities needed at UCS,larger spread in the SPE population.Advantage:only one structure of courses to be provi by SPEC staff,procedure established
   b) Start a full-time crash course during Sept-Nov. for 20 unquali Sc/M teachers in the field to prepare them for WP-STC training Disadvantage:doesnot fit with WP academic year,starting in May Advantage:facilities and Staff available for crash-course, WP training facilities used efficiently,funding probable from EDF budget (?)
   c) Start a seperate in-service course programme equivalent to present STC with a course duration of 3 years,similar to the insevice course program for untrained PTC teachers.Disadvantag training facilities at WP still under-used,new apparatus to b set up,extra staff + facilities needed(?),extra funding neede long duration.Advantage:training teachers remain in their schools.
4. To improve the quality of the unqualified teachers,who went into teaching straight after O'level,we thought of organising a crash course (half a year ?) to upgrade the content level, as they would have teaching experience. Upgrading could be e.g. STC with one major only.

PP22

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2 - 5 December 1981

POSITION PAPER P/1 'Considering three year high school education'

M.J. Nsibande, from a speech 'Some current issues in education planning and development in Swaziland', delivered at UCS on December 9th, 1980

> The university is an expensive institution. The cost is close to E 3000 per student. The length of courses at the university could be reduced to three years instead of four if the university could come out in very clear terms of what they expect of an 'O'-level student. For instance, currently the 'O'-level courses do not satisfy the minimum university expectations. This is why they have such things as the pre-science programme.
>
> There is therefore, a need for a dialogue between the Headmasters of High Schools, the university, representatives of colleges of agriculture, teachers, education, and technology including those of banks and industries - to determine minimum competencies expected at the end of High School education.
>
> This might necesitate a three year high school education which would be cheaper than one year at the university. This one sees some room of increasing education opportunities for many by reducing the costs of education at university level.

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2 - 5 December 1981

POSITION PAPER P/1 'How to improve secondary science education'

Dr. C. Stoll, recommendations based on experiences in SPEC/STU in Swaziland (1978-1981)

1. Whereas the teacher force in senior secondary education is characterized by the very high percentage of (qualified) expatriates, at junior secondary level the high percentage of un(der)qualified teachers is the most prominent feature of the teacher force. To break the vicious circle, which finds its cause in the low quality of secondary education, SPEC will only have a limited effect as it mainly contributes to efforts to eventually replace qualified expatriates by qualified locals. Therefore, vigorous supplementary action to improve junior secondary education by reducing the number of un(der)qualified teachers is needed. To this end more emphasis on in-service and pre-service teacher training for junior secondary level is advocated.

2. All schools should offer the same O-level syllabi and subjects for science and mathematics to the 'science stream' students. This would mean that all students entering post-secondary science-based programmes have gone through similar syllabi in mathematics and science. All parties involved (e.g. Teacher Training College, Ministry, University, etc.) should insist that all 'science stream students' be offered the same mathematics syllabus and as science subjects or physical science and biology, or physics, chemistry and biology.

PP24

The present position of LESPEC in Science/Maths based Post Secondary Education in Lesotho (1981)[1]

Institutions	Demanded Enrolment in First Year[2]	Actual Enrolment in First Year (81)	Projected LESPEC Contribution 82	Enrolment Other Years	Remarks
NTTC[3]	11	5 ?	15		output 1981: 6
LAC[4]	36	26	10	dropout rate is low	actual enrolment over the last years constant (20-25)
LP[4]	57	22	20	2nd year: 39 3rd year: 11	courses started recently; lower COSC passes go into craftsman courses
NUL[5]	85-95[6]	78	45 (+30)	dropout rate over 4 years is appr. 40%	

1. Nusery School, radio technician training etc not included
2. From: Summary of Tables from Burke's Report. Data cover the period 80-84 /85
3. Estimated demand for S + M teachers, demand arising from localisation JC teachers probably not included.
4. Projections on output, so input should be (somewhat) higher
5. Projected input
6. Basutu only; B Sc + B Sc Ed

Total projected input (and capacity ?) 125 - 150 students

Dr. W. Boontje
Maseru
December 1981

84

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PP25

Comparison between performance of students who have entered FOS through a Pre Entry Course and total class performance in Year 1 and Year of Faculty of Science NUL

FOS 1980/81 Year 1

Grade	A	B	C	D	E	F	TOTAL
PESC 1980	0	0	6	3	2	1	12
Class	2	7	13	22	10	2	56

FOS 1979/80 Year 1

Grade	A	B	C	D	E	F	TOTAL
PESC 1979	0	2	6	19	11	2	40
Class	0	15	20	41	25	4	105

FOS 1980/81 Year 2

Grade	A	B	C	D	E	F	TOTAL
PESC 1979	0	1	5	14	6	0	26
Class	0	6	27	31	9	1	74

A.L. Williams
Maseru, 5 December 1981

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PP26

REGIONAL F.U.A. BASIC SCIENCE MEETING DECEMBER 1981

P/2 Defining the target group

PESC - Botswana

Introduction

The definition of the target group will depend on how the function of the Pre-Entry Course is conceived. In general, one could define two major potential 'consumers': a B.Sc. degree programme or its equivalent and a (teaching) diploma programme. In the near future the pressure on the production of potential diploma students will increase considerably as a result of the new teacher training college which will be set up in Botswana. (the DSE programme will be phased out). It is unlikely that the Pre-Entry Science Course in Botswana will be able to cater for this in its present set-up. In the paragraphs below two ways of approaching this problem are given.

'Direct Entry' Approach

Analysis of the PESC selection test show that it is possible to isolate a group of approximately 30 high-ability students who are found in the top quartile of the selection score Q (see PESC Second Report 1981 p.6). Almost all of these students obtained a COSC first division and were recommended to join the degree programme. Therefore one could consider this group of students for direct entry to the degree programme without attending PESC.

This creates a few problems;

(1) The COSC subject combinations are not the same for all students and even so, the constant shortage of science teachers does not guarantee a proper understanding of the subject. Students who have attended PESC would definitely be at an advantage and this would create a diffuse starting point at the degree programme.

(2) The students who are selected for direct entry will need some guarantee that they will be admitted - regardless of their COSC results. This should also imply some of bonding so that not all of us are taken for training by the private sector. One can imagine what pressure a student would be subject to and this will definitely lead to the loss of a substantial number of candidates for the public sector.

(3) The students selected for direct entry would be idle between December and August. This will be to the detriment of their starting level in the degree programme unless they are employed in an area related to science (e.g. as demonstrators in secondary schools).

Some of the problems could be partly solved by the introduction of a short course just before the start of the academic year as envisaged in the LESPEC programme. However, the problem as mentioned in (1) can not be dealt with adequately in such a short course. Further, one can only hope that all direct entry students 'pass' it, because it will be difficult to refuse those students an entry to the degree programme.

Increased Enrolment

If one does not leave out a number of students for direct entry to the degree programme, then an increased enrolment is necessary in order to cater adequately for the diploma programme. It is expected that the number of students

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required for this last category will increase rapidly so that the enrolment targets of PESC will need revision (perhaps to 200). This also creates a few problems:

(1) Financial constraints in staffing and physical facilities might put a pressure on this additional 30 students;

(2) The abilities of the students will diverge considerably, which will necessitate a special approach.

An advantage of the increased enrolment is that at that it allows an amount of flexibility: a student can still'rehabilitate' himself/herself. Judging from the PESC 81 Selection data (PESC Second Report 1981 p.8), this happens to a rather large section of students in the bottom quartile. On the other hand, this would put quite some load on the teachers who would have to cope with students of very different abilities. This could be solved by the introduction of two different streams for particular subjects as soon as this flexibility is no longer required. Because of the fact that streaming would have consequences for the students' careers this should be introduced at the latest possible stage (if at all needed).

Conclusion

It is clear that the last alternative allows for more flexibility but at a price of higher costs and complicated teaching methods. The Direct Entry alternative as proposed for LESPEC is an interesting experiment and needs evaluation on the following points:

(a) Loss to private sector or otherwise of students selected for direct entry;

(b) Motivation of students for the short course and their performance;

(c) Performance of direct-entry students compared to 'LESPEC' students in the degree programme.

The present programme PESC and SPEC need evaluation on

(a) Effectiveness of the revised approach;

(b) Motivation of low-ability students to join diploma-programmes.

9th November, 1981
GABORONE.

G. de Jager
PRE-ENTRY SCIENCE COURSE.

GdeJ/fjm

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P/2 Defining the target group

-The Science Pre Entry Course program should focus on basic skills in Science and Mathematics and not be seen as part of FOS, WP, SCOTT Luvengo or THS. We should bear in mind however that nearly all our students are going to FOS or WP, so close cooperation with these institutions is important.

Bringing the weak ones up to a certain level (O'level) and stimulating the bright students is seen as the most important task of SPEC Sometimes at University the meaning is expressed, that SPEC should emphasize basic skills more than basic facts. Basic skills are e.g. English, studyskills, use of equipment, units, accuracy, use microscope, graph drawing and reading, etc. They claim that they will teach the content in first year as long as SPEC emphasizes the general skills. We however feel that the best way to teach these general skills is by means of scientific content.

-The level of knowledge of students in SPEC has a wide range in SPEC because

a. Students trying to qualify for W.Pitcher are of a lower level than the rest of the SPEC students

b. Some students didn't do certain science topics at form V level, so some have to start more or less from scratch

c. Their is a great difference in the performance of student nr1 of Swaziland and student nr 115 of Swaziland

Without considering if streaming is desirable, it creates huge problems in SPEC. How do you select the students for the different streams ? If different programs or/and different attention is offered to the different streams, it is not easy to make fair recommendations for admission into the different institutions at the end of May. Practically the group, which can be tought seperately from the rest without problems are the earmarked William Pitcher students. However the SPEC team feels the extra load, if two different programs are offered simultaneously. (see also S3)

-Not many students are performing so well, that we can say "these students do not need SPEC". Special because FOS offers common first year and many students missed certain science subjects at O'level. Only a few bright ones could be exempted from SPEC, but to select these bright ones, explaining and defending our choice will require much time/effort. We don't think it is worth doing.

PP28

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2 - 5 December 1981

POSITION PAPER P/2 'Direct Entry'

Prof.Dr. N.O.H. Setidisho, parts from internal FUA report 1981

Proposal for admission into the university

1. In order to meet the objective of increasing the university intakes into the science-mathematics programmes, as well as to make available a reasonable number for science-mathematics teacher training, the following proposal is being made:

   1) To increase the intakes into the science-based programmes, the universities should accept two parallel groups of students:

      a) Those who would be expected to obtain a first or second class division pass at the School Certificate Examinations, and

      b) Those who would get a third class pass or less, but who have demonstrated potential for the sciences.

   2) The first group should be considered as being eligible for direct entry to science programmes and should be admitted automatically. There should be no need for them to join the Pre-Entry Science Course.

   3) The second group should only be admitted on successful completion of the Pre-Entry Science Course and upon the recommendation of the Pre-Entry Science Team.

   4) Students from both groups should have:

      a) an accepted minimum level of achievement in the sciences and mathematics; and

      b) demonstrable aptitude for the sciences and mathematics.

Criteria for Direct Entry

2. It recommended that students who should be considered for direct entry should be:

   - A first class division pass with mathematics and at least one acceptable science subject (Physical Science, Physics or Chemistry).
   - A good second class pass with a credit in mathematics and either Physical Science or Physics or Chemistry.

3. If a student is selected for direct entry, and on the basis of the School Certificate results, he is disqualified, then it is recommended that such a student should join the Pre-Entry Science Course within 10 days of the announcement of the results.

4. In the case of a student in the Pre-Entry Science Course who is then found to qualify for direct entry, it is recommended that such a student should continue with the Pre-Entry Science Course, but should be considered automatically eligible for direct entry.

Direct Entry students need Pre-Entry Science

5. It has always been argued that students who ordinarily qualified for direct admission also need some kind of upgrading course and that they should necessarily join the Pre-Entry Science Course. This has had two disadvantages:

    - Depriving some other deserving, but less fortunate, student of the opportunity to qualify himself for admission through the Pre-Entry Science Course, which is a second chance route in a situation in which there are environmental inequities.
    - Reducing the number of potential students who could be upgraded and so qualify for admission and hence increase the science intakes substantially.

6. If it is true that direct entry students actually need an upgrading remedial course, then it is recommended that, subject to the availability of the means to do it:

- such a course should be arranged for them
- the course to extend over a period of six to eight weeks
- the course to be run by the staff to the Faculty of Science.

7. It is generally preferred that such a course should be run prior to the beginning of the academic year since the Faculty of Science staff would have no other teaching responsibilities and so could devote all their time and energies to this programme.

Advantages of the strategy

8. A system of direct entry would have the following advantages:

    - It will contribute significantly to an increased number of science intakes into the university.
    - It is more likely to cater better for the other post-secondary education institutions.
    - The Pre-Entry Science Course group will be more homogeneous, and hence teaching will be facilitated.
    - Would give a second chance to a greater number of disadvantaged students form the school system.
    - Would be more likely to be an incentive to secondary school teachers to know that their best students do not necessarily need an intensive remedial training programme. The students themselves would probably be encouraged to work harder in order to go in through the direct route.

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2 - 5 December 1981

POSITION PAPER P/2 'A system of Programme Quotas'

Prof.Dr. N.O.H. Setidisho, parts from internal FUA report 1981

1. A general, but very important objective of the Pre-Entry Science Course has been:
   - To increase the number of students for the science based study programmes; and in particular,
   - To provided the university with a substantially increased number of students for training as teachers of the sciences and mathematics.

2. Over the current period of the existence of the Pre-Entry Science Course, there has been a significant increase in the number of science students, yet at the same time there has been no increase in the number of students for science teacher training and also for the Part 2 science courses of the university. Thus, the vicious circle continues and the schools continue to survive on a temporary teaching staff and so suffer all the ill-effects of lack of continuity in teaching and an acute shortage of science-mathematics teachers.

3. Some of the causes of the situation may be described as follows:
   - A number of the best students are withdrawn from the Pre-Entry Science Course to be sent to institutions in other countries for programmes which are supposedly not available at home.
   - At the end of Part 1 Science studies, the majority of the students are transferred to programmes in other countries.
   - The unwillingness of students to go into a programme of science teacher training.

4. It is conceded that there is a general shortage of manpower in a wide range of occupational fields, and that it is necessary to have a number of people trained in these fields. However, it is necessary that there should be an equitable distribution of students among the various occupational training programmes and priorities must be set.

5. A necessary first step is to agree on at least two priorities:
   - Science-teacher training at both the degree and diploma level.
   - A general boost for Part 2 Science Teaching.

6. It would be important to agree on a minimum number of students for:
   - Science degree with a view to teaching; and
   - The Diploma in Secondary Education with science.

7. Once the quotas have been agreed by the partner institutions and the Government authorities, the next step would be to design a mechanism that will guarantee that the policy is carried out.

8. It is recommended that there should be a University/Government Committee whose function would be:

   - To formulate a policy for the application of a quota system.
   - To determine the number of students to be admitted into each of the programmes including transfers, and more particularly to approve the quotas for science-based studies.

9. Students are very often unwilling to join and often resist training for teaching. Salaries for teachers and conditions of service have improved a great deal over the years and it can only be surmised that the resistance to teaching is due mainly to:

   - The apparent loss of status in society of the teaching profession.
   - The standing of the teaching profession in the power structure of the country.

10. In the light of the above, it might be useful to discuss a number of possible incentives in order to attract school leavers to the teaching profession. Otherwise it may be very difficult to break the vicious circle.

11. It is suggested to consider the introduction of at least two types of incentives:

    - Free scholarships for top priority areas of study.
    - Loan scholarships for other areas of study. Programmes which come under this category could be classified into three groups:

      a. Refund one-quarter of the value of the scholarship.

      b. Refund one-half of the value of the scholarship.

      c. Refund the full amount of the scholarship.

12. The priority areas of study may be determined by the Committee established to monitor the scheme. However, where students have to refund the full amount, they would be allowed to choose any programme of their liking which is not on the priority list subject to the approval of the monitoring Committee.

13. It would do the universities a great deal of good if they could avoid being involved in having to transfer some of their best students to universities elsewhere. The Nigerian Universities with their Pre-University Course did not transfer any of their students. Those who had to go elsewhere did so directly from the A-level schools in the country.

14. It would perhaps, be an advantage to strengthen the existing A-level institutions within the Boleswa Region and to establish that the basis for their existence is to prepare students for transfer. Those who do not make the grade for transfer could be considered for other training programmes at home, including the university.

1. INTRODUCTION

1.1. Approximately 150 students have to be selected and ranked according to merit.

1.1.1. the 30 best go into the so_called direct entry stream and will not be invited to LESPEC

1.1.2. the next 100 will be invited to LESPEC

1.1.3. the 20 students thereafter will be placed on a reserve list according to merit. These 20 are meant to fill up the places not accepted by invited students.

1.2. According to the Plan of Ops (page 8) a ranking list of a few hundred students has to be compiled first

1.3. The data used were the actual scores in the LESPEC Maths Test (LMT) and data obtained from the Teacher's Ranking List (TRL).

1.4. The aptitude test were not used in this stage,as they were not administered at all schools. Moreover the tests themselves were not validated. The data obtained this year can be used for that. This year's results will be used in border cases only.

1.5. Attention should be payed to students from backward schools

2. COMPARISON OF SCHOOLS

2.1. Statement: the students tested from one school can be considered as a random sample out of the total population of all students tested.

2.2. The flaw in this statement is that some schools select their students at several levels and other schools do not.

2.3. Such a pre-selection would cause the distribution of students acievements to deviate from a Gaussian distribution. This actually happens to the case for the LMT scores.

2.4. Given the fact of some pre-selection and its probable effct on the distribution of acievements in the schools, it seems not to be justified to compare directly students differently ranked from different schools.

2.5. Based on LMT results schools were classified into three categories:

G: mean score in LMT $\geq$ 8 (out of 23)
M: 6 or 7
P: $<$ 6

2.6. Some minor shifts of school from one category to another were done based on previous COSC results.

2.7. The distribution of LMT scored within the categories G,M and P approached a normal distribution satisfactorily.
The mean and the standard deviation in G,M and P category were respectively 9,1 . 3,60; 6,4 . 2,07; 4,9 , 2,36

2.8. The statement from 2.1. can be modified to :
Tested students from one school can be considered as a random sample out of the population of all students tested from schools in a particular category.

3. COMBINING LMT RESULTS AND TRL NUMBERS

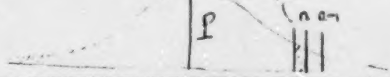
3.1. The TRL numbers were used to predict a score in a hypothetical test.

3.2. Let N be the number of students tested from a school.
Let n be the TRL number of a student.

3.3. Based on the TRL numbers students of one school were thought to be spaced by equal intervals (surface portions 100/N).

3.4. So a student ranked n would have a (predicted) score higher than $\frac{100}{N} \times (N-n)$ of the students of his group.
E.g. a student ranked 2 from a class of 20 would have a score higher than $\frac{100}{20} \times (20-2)$ = 90% of his fellow students that wrote the test. See fig.

Fig



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3.5. As such an approach yields a minimum score, the middle of the interval was used in the calculations. So instead of n the number n-0.5 was used.

3.6. Statistical tables were used to convert the percentages found (area's P under the normal curve) to standardized scores (a mean of 0 and a standard deviation of 1).

3.7. Using the mean and the standard deviation actually found in LMT for the 3 different categories of schools, the predicted score is obtained. This score is on the same scale now as the actual LMT scores.

3.8. The aggregate of actual score and predicted one is processed further.

4. COMPARISON OF STUDENTS FROM SCHOOLS OUT OF THE SAME CATEGORY.

4.1. These students were ranked according to their aggregate score.

5. COMPARISON OF STUDENTS FROM SCHOOLS OUT OF DIFFERENT CATEGORIES.

5.1. Comparison of these students according to their aggregate is unsatisfactory because that does not account for:

5.1.1. the fact that an actual score a obtained by a student in a M school is a relatively better performance than the same score obtained by a student in a G school. (In a G school the chance is higher to obtain a better score).

5.1.2. the fact that student in M schools will be assigned predicted scores based on a lower mean than students in G schools, which defies statement 1.4.

5.2. With regard to 1.4. and 5.1 students of G and M schools were compared by using predicted scores (and actual ones) based on the mean and standard deviation found for G schools.
In practise this meant that the TRL numbers of students from M schools were somewhat overvalued.

5.3. In the same way students from M and P schools were compared.

6. THE TOTAL RANKING LIST

6.1. A first ranking list was drawn up for students from G and M schools, based on aggregates (see 5.2)

6.2. This list was compared with a second list for students from M and P schools

6.3. This resulted in inserting students from P schools between students from M schools, already on the first list.

6.4. The calculation of predicted scores by using a higher mean than actually found in a certain category of schools may upset the rankin of students within a particular category. (This was done for M schoo in 6.I and for P schools in 6.2).
This is because the TRL numbers become overvalued, which is not justified when students from schools out of the same catagory are compared.
There fore the mutual positions of students from the same category (schools was maintained and restored in the final ranking list.

6.5. A simple example will clearify the principle:
assume the following rankings were obtained:

G schools	M schools	G + M schools	restored ranking
GI	MI	GI	GI
G2	M2	G2	G2
G3	M3	G3	G3
G4	M4	MI	MI
		M3	M2
		G4	G4
		M2	M3

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7. THE TOP 30 students

7.I. Those students were tentatively selected according to scores in a) LMT and the scores in b) discriminative questions of LMT. These two data were used to be able to recognize and omit some of th lucky scoring students.

7.2. Selected for direct entry stream: a) ≥ IO out of 25
b) ≥ 8 out of I4

7.3. In some cases students were selected by inclusion. That is: a student ranked lower scored very high. The students of that school ranked higher will benefit from that high score.

7.4. This method resulted in 58 selected students

7.5. Based on the quality of the school and TRL some were struck off the list and 29 remained on it.

7.6. These 29 occupy the top 58 places in the total ranking described above

7.7. Some fine adjustment of this direct entry group has to be done.

Dr. W. Boontje

REGIONAL F.U.A. BASIC SCIENCE MEETING DECEMBER 1981

P/3 Methods and Problems of Selection

PESC - Botswana

1. Compromise Between Aptitude and Achievement

When PESC is defined as a'second-chance' type of education, the need arises to select students more on the basis of aptitude than on achievement. However, apart from the difficulty to construct suitable aptitude tests, there is also a limit to what can be done in the relatively short period of the course. Therefore a compromise between achievement and aptitude is needed. At present the selection of students for PESC is based on:

- teachers' ranking 50%
- achievement tests in science and math 33%
- aptitude tests ('Hidden figures' and 'Symbol Exclusion') 17%.

This does not mean, however, that aptitude is given a weight of only 17%. The other paremeters also include an aptitude element because the achievement tests contain 'aptitude questions'. Moreover, the teachers are free to rank their students according to ability. So far the weighing produces quite satisfactory results in terms of PESC results.

The same argument in favour of the introduction of achievement test can be used for the selection of categories of students who are admitted to the selection tests for Pre Entry.

In Botswana, there are about 400 students who are currently taking Physical Science and Biology at the COSC examinations; eighty who take two or more separate sciences (Biology, Chemistry and Physics), 200 who take General Science and a further 300 who take only Biology. We excluded the students writing Biology only from the selection, because in our opinion, their basis of preparation was too shallow and they were likely to fail. This leaves us still with 600 plus candidates to select 150 students from.

2. Combination of Teachers' Ranking and Test Scores

The nature of the ranking numbers is very different from the test scores and need transformation. In PESC this is done by transforming the ranking numbers to approximately the same basis as the combined test-scores (with the same average and standard deviation).

It is quite difficult to combine the ranking (which is specific to every school) on a nationwide distribution. If all schools had the same average quality of students, it would be best to model the ranking distribution to the national distribution of test-scores. This is unfortunately not the case: the average quality of students as measured by COSC and PESC results, varies from year to year for every school.

Therefore the ranking needs some moderation . In previous years we corrected for the school size only. For example, a student ranked number 3 in a large school could get a score equivalent to a student ranked number 2 in a small school, where the size of the school is determined by the number of students writing the selection test.

This year this was further modified by limiting the number of students with individual transformed ranks in a school, and giving all other students the median transformed rank of the remainder.

This was done because in some schools, teachers were unable to give all students an individual rank. In most schools the teachers were confident about their rank for the top half, but not so for the bottom half of their students. This could create a bias (in favour of large schools) which may be avoided by relating the number of ranked students to the test performance in that school (see Appendix): If in a certain school 10 out of 30 students scored better than the (national) average, then the first ten students on the teachers' ranking (not necessarily the same students who scored better than average) were given individual transformed ranks. All remaining 20 students were given the same median transformed rank, which was usually lower than the national average test-score.

3. The Aptitude Tests

So far we have not seen very encouraging results from the aptitude tests. Correlation analysis with PESC final results give very low coefficients (less than 0.10). The analysis of the PESC 81 selection data (see Second Report 1981, para 1:6.2) confirm this picture, even after a case by case analysis. We believe therefore that there is an urgent need to replace the present aptitude test with some tests which give better prediction. Perhaps EMES could render a service to all projects in the area.

12th November, 1981
GABORONE.

GdeJ/fjm

ANNEX 2 to 'Admissions PESC 1982'

Transformation of the teachers' ranking

1. Let the weighted means of the test scores have a distribution with mean 50 and standard deviation σ (fig. 1)

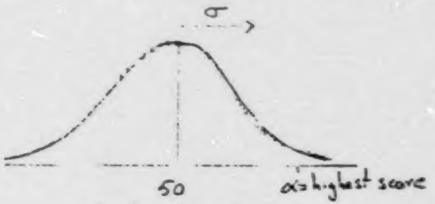

Fig 1

then we approximate this distribution by a triangular distribution with density function f in such a way that the base of the triangle equals 2 $(\alpha-50)$ (fig 2).

f is a density function, → $\int_{100-\alpha}^{\alpha} f(x)dx=1$

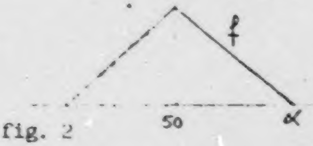

fig. 2

$\Longrightarrow$ height triangle $= \frac{1}{\alpha-50}$

$\Longrightarrow$ formula f:

$$f(x) = \frac{1}{(\alpha-50)^2}\left[x-(100-\alpha)\right] \qquad 100-\alpha \leq x \leq 50$$

$$f(x) = \frac{1}{(\alpha-50)^2}\left[\alpha-x\right] \qquad 50 \leq x \leq \alpha$$

2. How to convert the ranking of students in a school where N students participated in the test ?

   a. The lowest score should approach α and the highest $100-\alpha$
   b. To convert the ranks into scores we divide the triangle in N + 1 parts:
      N -1 with an area $\frac{1}{N}$
      and 2 with an area of $\frac{1}{N+1}$ see fig 3

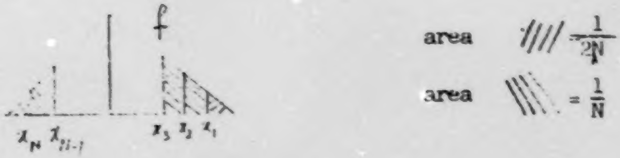

fig 3

The predicted score x_R of student with rank R will be the lower limit of the R^{th} part counted from right to left.

So students with ranks R and $R \geq \frac{N+1}{2}$ will get score x_R as follows:

$$N \int_{100-\alpha}^{x_R} f(x)\,dx = N - R + \tfrac{1}{2}$$

$$N \int_{100-\alpha}^{x_R} \frac{1}{(\alpha-50)^2}\left[\alpha - x\right] dx = N-R+\tfrac{1}{2}$$

$$\longrightarrow x_R = 100-\alpha + (\alpha-50)\sqrt{2-\frac{2R-1}{N}}$$

Students with ranks R and $R \leq \frac{N+1}{2}$ will get score x_R as follows:

$$N \int_{50}^{x_R} \frac{1}{(\alpha-50)^2}\left[100-(100-\alpha)\right] dx = N-R+\tfrac{1}{2}$$

$$\longrightarrow x_R = \alpha - (\alpha-50)\sqrt{\frac{2R-1}{N}}$$

3 . Characteristics of X_R:

a. X_R symmetrical in 50

b. $\lim_{N \to \infty} x_1 = \alpha$

c. $\lim_{N \to \infty} x_N = 100-\alpha$

4. Let the number of students with a T-score higher than 50 be N_T, then the students with rank:

$$R \leq N_T$$

are allocated a transformed rank according to the formulae of para. 2 above. All other students with rank:

$$R \geq N_T$$

are given the median rank of the remaining students, which is obtained by dividing in two that part of the area of the triangle which remains after subtracting the area corresponding to the N_T students. (see fig 4)

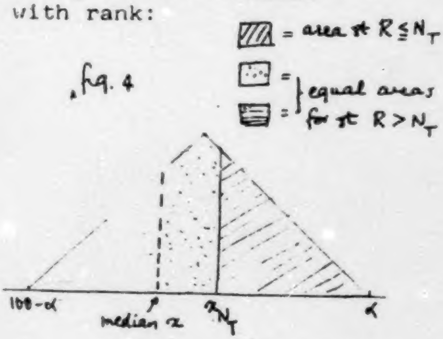
fig. 4

3/.......

5. Example

Analysis of the T scores shows that $\alpha = 70.82$, so that the maximum score is 70.82 and the minimum 29.18. In Kgari Sechele Secondary School 23 students participated in the test of whom 11 obtained a T score higher than 50, so that:

$\alpha = 70.82$
$N = 23$
$N_T = 11$

Using the formula: $\alpha_R = \alpha - (\alpha - 50)\ \frac{2R-1}{N}$,

which converts to: $\alpha_R = 70.82 - 20.82\ \frac{2R-1}{23}$

and substituting the values 1,2,3,...,11 for R, you obtain:

R	transformed rank
1	66.48
2	63.33
3	61.11
4	59.33
5	57.80
6	56.42
7	55.17
8	54.01
9	52.92
10	51.90
11	50.93

The remaining students with rank higher than 11 are given the transformed rank 44.83, at which point the remainder of the triangle is divided into two equal parts.

P/3 Methods and problems of selection (SPEC/STU team)

-We are still not sure if the aptitude test,we are using as part of our selection,is tracing potential capable science students. The correlations between the performance in the aptitude test and O'Level/SPEC results are low and do we have to conclude now,that the aptitude test is not a good selecting instrument for selecting potential scienec students ? We like to know .
Are their many potential science students somewhere in the country, who due to bad teaching missed their chance ?Our experience is that there are not many potential students lost (or we can not trace them).

-At the other side the maths achievement test correlates rather well with the students O level and SPEC results,so this test seems to be a more reliable predictor for SPEC.
The teacher's ranking seems a very good idea,but you cannot compare the students of the different schools,e.g. nr 17 of Mahambe (weak school) is certainly not better than Salesian (our main supplier).
Nextyear we think of trying a combination of Aptitude/Maths achievement, Ranking.

-Requesting one science subject is enough in Swaziland,where some schools only offer 1 science subject.
It is a pity,that our students are not doing all science subjects at high school.It would be nice if we could'build' on former high school knowledge

General the feeling is,that the selection was quite successful in the past and that investing more time/money will not automatically lead to a better selection.
Our past experience is that after O'level about 12 students come with their first or second pass + credits in Maths and English.The disadvantage of taking in these students is that, they enter SPEC 1 month later,the advantage is that we can miss really bright students without to many comments of the schools because "they can still come in after O'level".(We do actually miss not many really good students)

Question:How accurate can we assume a single selection session to be?

PP33

Position paper on Selection in Education in Southern Africa.

Prof. Dr. P.J.D. Drenth,
Amsterdam, Nov. 1981.

1. Most of the formal principles of educational selection are applicable in Botswana, Lesotho and Swaziland. A number of specific situational conditions, however, require a somewhat specific approach or "translation".

2. It is incorrect to assume that selection on the basis of selection variables (called predictors) is necessary as a matter of course.
No selection is required or desirable in case:

   (i) No differences in criterion performance exist or can be measured.
   Comment: This condition does not apply in BOLESWA. Clear differences in performance in PESC, SPEC and University can be observed.

   (ii) Selection is not acceptable on legal or political grounds, e.g. if a diploma is perceived as giving the principal right for admission. If the number of applicants exceeds the number of places, in fact drawing lots is the only solution (cf. point of view of socialist party with respect to entry medical school in the Netherlands).
   Comment: Does not seem applicable in BOLESWA. Given scarcity of educational facilities and need for maximal utilization of resources and educational talent this does not seem realistic.

   (iii) No valid predictor is available.
   Comment: This does not apply. Previous research in Botswana and Swaziland show (varying) predictive validities for schoolrecords, teacher ratings, achievement tests and aptitude tests.

   (iv) Base rate is extremely high. In other words almost everybody in the pool of applicants would be succesful in the training. In such circumstances the costs of testing could become higher than the costs of training the few unsuccesful students.
   Comment: This is certainly not realistic for the BOLESWA-situation.

3. In case selection is possible and desirable which strategy is optimal? One classical model is the empiristic approach. This means: selection of predictors solely on the basis of their correlations with the criterion.
Steps: Compute multiple correlations with criterion. Compose maximally predicting battery with beta weights for predictors. Any predictor can be included provided it increases the multiple correlation.
Comment: Psychological and ethical criticism possible.

(i) Which criterion should be used? PESC end results? PESC gain scores (differences entry-final exam)? Part I scores? Part II scores? Report Hoogteyling: Some tests do not correlate with PESC, but do correlate with university performance!

(ii) Empiristic approach aims at maximizing institutional utility. Those applicants are selected that perform best in the training. Possible discrimination of minority groups (low quality schools, remote urban areas, little environmental support) is taken for granted. In fact, "quality school" could very well be a valid predictor to be included in the selection battery (as dummy variable). This would go against one of the principles of PESC, SPEC and LE[illegible]EC: which is to provide a second chance!

4. Aside from biographical and socio economic data, teacher ratings and personality measures a choice can be made from measures of achievement or intelligence/aptitude. It is good to realize that this distinction does not refer to a dichotomy but rather to a continuum ranging from a postulated concept of inborn potential intelligence (intelligence A) to a very specific concrete exam on a particular subject treated in a particular textbook or syllabus (F). As figure 1 shows there is a range of tests and exam types in the grey area between these two extremes.

- A. Intelligence A. Potential inborn capacity. Not to be measured, even with so called "culture free" tests.
- B. Intelligence B. General ability level as product of inborn capacity and learning experience.
  Measure: G-factor in intelligence tests or (proxies) score in omnibus intelligence test, or sum subtestscores in testbattery.
- C. Intelligence factors or aptitudes. Either "pure" factors (verbal, reasoning, space, numerical, memory, flexibility) or combinations of factors into relevant aptitudes (technical insight, verbal comprehension).
- D. Achievement tests, but with emphasis on application of knowledge, insight, synthesis, being able to work with learned principles.
- E. Achievement tests reflecting general educational objectives.
- F. Specific essay type or m.c. type exams on particular subject, domain or skill.

Figure 1. Spectrum of abilities

A, B, C: Generally called "intelligence" or "aptitude" tests. Primary function of these tests: Forward looking; used in predictive settings (selection, vocational choice, school guidance).

D, E, F: Generally called "achievement" tests. Primary function: back looking. Used to evaluate the extent to which educational or training goals have been achieved. Used at individual level (evaluation of achievements of individual students) or at system level (evaluation of succes of training or education). Secondary function: for predictive purposes. Achievement testscores, school records, exam results can be used for selection and admission purposes. This is not without possible dangers, particularly in developing countries, see sub. 5.

5. In BOLESWA: achievement scores (school records, exam results, achievement tests) or intelligence/aptitude test scores as predictors?

Arguments for achievement:

a) Educational argument: If there is a gap in knowledge or skills (mathematics, English) the student will not be able to benefit sufficiently from subsequent learning.

b) Psychometric argument: Best predictors of schoolperformance are usually scores for previous similar school performance. In other words, score physics high school, or COSC will likely correlate highly with score physics in PESC, or university (see e.g. data Swaziland).

Comment: Ad. a: Correct argument. However, (i) this calls for absolute measurement (establishing minimum standards in knowledge of skill) rather than relative measurement (the more the better chance for admission) see also argument ad. b. (ii) It should be reasonable to expect that the student will not be in a position to develop the skill or to attain the knowledge during the course of study (independent study or remedial training). This is a strong point. We have to realize that PESC was intended to provide this extra avenue, particularly for students who have not had sufficient chances on their high school.
In other words: capitalizing on achievements will make the rich richer and the poor poorer.

Ad. b: School performance is dependent on two variables. (1) Student's scholastic aptitude, and (2) quality of education. Where (2) is uniform in a country (1) becomes more pertinent. But where (2) varies extensively in a country (such as is the case in BOLESWA) schoolperformance reflects the student's capacities to a lesser extent. Capitalizing on school performance discriminates against children from poorer schools (e.g. remote urban regio's).

These contra arguments become stronger, the more one goes down the continuum of abilities (stronger for F than for D).

Use of aptitude tests?

If one goes even higher up the line of the spectrum the dependability on school quality and environmental support becomes weaker, the extreme case being a (non-existent) intelligence A-test. There is another danger however, and that is that the concept being measured becomes more and more remote from the criterion. Training even at university level requires specific learning and educational aptitudes and not (just) "pure" intelligence. In other words A or B type tests might show a lower predictive validity than C type tests.
So the dilemma is: less discriminating (A, B) tests are probably less valid. More valid tests (C) are again more similar to achievement tests in involving the danger of discrimination (however less so than D and particularly E, F).
(Own research experience in Tanzania and Kenya shows that C type tests have a higher validity indeed than B type tests).

From the above formulated stance the following discussion model emerges.

a) Use school performance and achievement scores as criterion for admission where a logically plausible relationship exists between required achievements in the high school subjects and the learning processes in the next and where the gap cannot be bridged by extra learning or remedial training.
b) Cut off points should be established on educational grounds, rather than on the basis of supply and demand.

c) If the number of applicants after b) is still larger than the number of places, further selection should be based upon predictors that are less dependent on quality of school and environment.

d) For this purpose aptitude tests may be considered, provided they have some validity (demonstrated in research on not too restricted and homogeneous samples, see 6).

e) Other predictors may function as well.

A possible predictor to be considered is "teacher rating". It has the disadvantage of being subjective and possibly biased, but potentially it may include: motivation of the student, correct learning set, attitudes and values in addition to achievement and (possibly) intelligence. It is interesting to see that in the recent BOLESWA report teacher ratings seem to come out as rather valid predictors of PESC performance.

6. Requirements for aptitude tests.

a) Not too restricted as far as content is concerned.
b) Specific combination of subtests more effective than total sum.
c) They should be carefully constructed, item analyzed and composed.
d) They should be administered and scored in a highly standardized fashion.
e) They should be sufficiently reliable and have a clear and interpretable (factor analytic) meaning.
f) Research needed to demonstrate qualities of tests in each country.
g) Various criteria should be used for validation. Too high correlation with PESC results may not be desirable, since it would pull them too close to the achievement scores. Too high correlations with school performance and COSC results not either, for the same reason. They should measure something relatively independent from achievement.
h) One needs larger samples than the restricted groups that are admitted to PESC, SPEC, LESPEC. These samples show a substantial restriction of range, particularly if selected on the basis of the predictor to be evaluated.

Don't forget that most relevant decisions are not made within accepted group, but with respect to rejected group. No or low correlations with criterion scores within the accepted sample does not exclude possibility of a higher correlation in the total group of applicants, due to restriction of range or curvelinear relationship which is often found in educational selection with low selection ratio (see fig. 2).

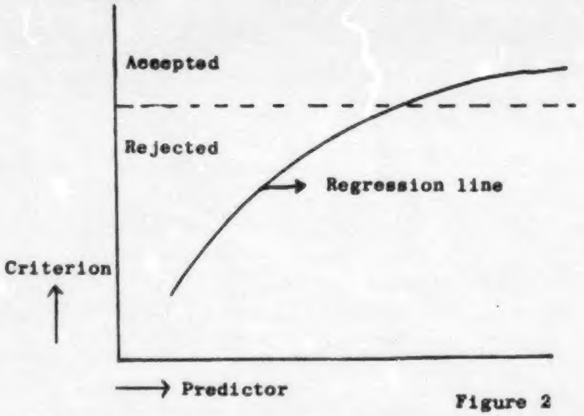

Figure 2

7. Some preliminary data from Swaziland SPEC may illustrate a few points made in the previous discourse. The analysis has been finished only very recently and the interpretation is only tentative. A more extensive and full report will follow later.

See Annex I.

Comments:

(i) : Correlation VU tests total and SPEC results are reasonably high for 1979. They drop strongly in 1980 and show some raise again in 1981. This may reflect the selection strategy. In 1979 the emphasis was on school performance, in 1980 and (less strongly) 1981 the emphasis was on test results (see Annex II). This leads to a restriction of range in the dimension of emphasis and, accordingly, to lower correlations for that dimension. In this connection it is interesting to see that the Mock examination (achievement!) shows an opposite picture.

(ii) Strongest predictors for SPEC and university results are COSC results. This is in accordance with the statement sub 5-b.

(iii) There is quite some variance over the years, not only with respect to the validities of the VU tests, but also with respect to the correlations of the Hay exam and the COSC scores with both SPEC and university results. This may reflect inconsistency in educational policy, rating, type of training or evaluation standards. No data are available for testing this hypothesis.

(iv) No significant correlations have been found between tests (and Mock 1979) and university results. This is somewhat surprising, particularl since in Botswana some tests (particularly Mathematics) showed significant correlations with the first year results. Reason: restriction of range? Lower reliability of test due to insufficient standardization? Low predictive power of the tests in Swaziland due to specific character of criteria?

(v) The tests are speeded. This calls for careful standardization of instructions, timing, testsetting etc. We have no indications of the extent to which this could be controled. What is the feeling of SPEC team?

Somewhat puzzling was the fact that over 75% of the scores which the SPEC team calculated were incorrect. They had to be recalculated before the analysis could be done.

		SPEC						1st year	MOCK/	COSC		
		MATH	PHYS	CHEM	BIO	ENG	OWM	OWM	HAY	MATH	ENG	AGGR
Test 1 t/m 5	'79	.33**	.28**	.31**	.26*	.30**	.36**	.04	.44**	.48**	.26**	.35**
"	'80	.13	.31	.16	.17	.17	.24*	.08	-.04	.13	.25**	.17
"	'81	.23*	.18*	.20*	-.03	.27**	.23*		.16	.28**	.36**	.25*
Test 3 t/m 5	'79	.27*	.37**	.41**	.43**	.40**	.46**	.08	.36**	.42**	.41**	.35**
"	'80	.14	.33**	.23*	.18*	.22*	.27**	.08	-.03	.10	.29**	.16
"	'81	.14	.18*	.13	-.09	.25**	.16		.10	.27**	.38**	.26**
MOCK	'79	.28	.29	.26	.27	.06	.30	.28				
HAY	'80	.62**	.52**	.52**	.19*	.37**	.56**	.40**		.57**	.26**	.38**
HAY	'81	.63**	.60**	.44**	.14	.14	.56**			.71**	.15	.39**
COSC-aggr.	'79	.49**	.62**	.62**	.53**	.54**	.70**	.57**	.52**			
"	'80	.45**	.34**	.26**	.25**	.36**	.41**	.22*	.38**			
"	'81	.40**	.43**	.45**	.35**	.43**	.55**		.39**			

* sign. at 5% level

** sign. at 1% level

ANNEX II

SELECTION PROCEDURES SWAZILAND

SPEC '79	SPEC '80	SPEC '81
- 2 best students from each school, based on school results for Math. + Engl. (54)	- best student of each school, based on VU tests + recomm. teacher (30)	- best student on each school based on VU tests + recomm. teacher (31)
- score $\geq$ 402 on sum testscores VU + Myeni (55)	- score $\geq$ 120 VU test + recomm. teacher (48)	- score $\geq$ 120 on VU test $\geq$ 60% on Hay + recomm. teacher (24)
- foreign students based on school results (7)	- VU test 115-119 + recomm. teacher + $\geq$ 40% Hay ex. (4)	- score $\geq$ 115 on VU test $\geq$ 55% on Hay + recomm. teacher (18)
- mature age based on VU tests (5)	- $\geq$ 120 VU tests, recomm. teacher weak, $\geq$ 40% Hay ex. (9)	- score $\geq$ 110 on VU tests + $\geq$ 50% on Hay + recomm. teacher (33)
- COSC results (10)	- 110-119 VU tests + recomm. teacher + $\geq$ 50% Hay ex. (15)	- $\geq$ 60% on Hay + belonging to top ten of school (2
	- recomm. teacher + $\geq$ 60% in Hay (15)	
↓	↓	↓
Emphasis on schoolperformance	Emphasis on aptitude tests	More combination, most like '80

In SPEC '81 aptitude test battery 'Figure Exclusion' and 'Mathematics I' have been replaced by 'Number Series' and 'Mathematics II'.

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2 - 5 December 1981

POSITION PAPER P/3 "Selection procedure"

Prof.Dr. N.O.H. Setidisho, parts from internal FUA report 1981

Procedure

1. The selection procedure should continue to consist of the following elements:

- The recommendations of the Headmasters of the Secondary Schools which have School Certificate candidates.
- Ranking of the students by their science teachers.
  Where there is more than one teacher involved in teaching the sciences, then each teacher should produce his or her own ranking for his class and in his science subject.
- The design of Achievement Tests in the sciences and mathematics; by their very nature, these could be diagnostic as well, that is, if that is possible.
- The design of a set of Aptitude Tests to isolate potential for science and mathematics. It is important to stress the phrase potential for science and mathematics since General Intelligence, it is assumed, is not a necessary and sufficient condition for success in the sciences and mathematics.

The Achievement Tests

2. The ultimate objective is that the students should be admitted into one or other science based programme, degree of diploma. Such programme will necessarily demand that the students should have

- reached a certain minimum level of achievement in science and mathematics.
- some indication of potential for successful comprehension of the needed basic scientific and mathematical concepts.

3. Hence it is clearly necessary that the Pre-Entry Science Project Teams should design fairly reliable achievement tests which would help to establish that a particular student has reached a helpful minimum level of achievement for three reasons:

- To ensure that the Pre-Entry Science Course will reach a reasonable level of achievement compatible with levels of achievement normally assumed by the post-secondary institutions to which the students may by admitted.
- To assist the Pre-Entry Science Course help the student develop a fair measure of confidence in himself for coping with science-based studies.
- To fit in better into the science-based programmes into which they may be admitted

Bank of Achievement Test Items

4. In view of their importance and in order to avoid annual repetition of the same test items, it is advised that the Pre-Entry Science Team

should try to build up a bank of reliable test items for the Achievement Tests.
How this can be best achieved is a matter for detailed discussion for both the Pre-Entry Science Team and the Psychologists. The teachers of science and mathematics in the schools could be asked to submit possible test items which could then be refined by the Pre-Entry Science Team.

Aptitude tests

5. The objective is to design Aptitude Tests which will help:

- identify students who are not only intelligent, but who also have academic potential for science and mathematics.
- isolate students who are more likely to cope with degree and/or diploma studies with a science orientation.

6. It is assumed that it is possible to design Aptitude Tests which can meet the particular needs of science and mathematics, and hence it is being proposed that such a test battery should be designed.

Responsibility for Aptitude Test Design

7. The Psychologists have the expertise to design Aptitude Tests of various kinds, and of course, the subject matter specialists have a very good idea of the variety of the very basic and needed science and mathematics concepts.

8. In view of the above, it is thought that the chances of success in designing such a battery would be increased if the choice and development of these tests could be done by the Psychologists in very close consultation with the subject matter specialists who will be involved in the teaching.
The subject matter specialists are better qualified to check whether the various items of the Aptitude Tests have a resonable chance of relating closely to the basic processes needed in the sciences. Machinery should be set up for such a consultation process to take place.

Cultural and Environmental factors on Test Performance

9. It has been shown in studies elsewhere that aptitude testing and general achievement can be influenced by cultural factors and the environmental conditions such as:

- the socio-economic circumstances of the family.
- the nature of the home background of the students as well as the rural or urban location of the school.
- the quality of teaching in the school.

10. Given the diversity of schools in any one country of the Region, it is well known that there is no homogeneity of environment and quality of teaching, and therefore, it should be expected that performance in the tests to be used for selection and for identifying potential might be affected accordingly.

11. In view of above, it is considered that, in the interests of equity, there should be a system of quotas for the schools so that the best students in each school should have a reasonable chance of being admitted into the programmes. Past experience in this matter may be a useful guideline. However, one possibility could be to offer the top three students in each school either direct entry or the Pre-Entry Science, the determining factor for direct entry being the level of performance in the tests.

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REGIONAL F.U.A. BASIC SCIENCE MEETING DECEMBER 1981

P/4 Position of the Projects in the Educational System

PESC - Botswana

1. Pros and Cons of Pre-Entry Courses

As negative aspects of pre-entry courses may be mentioned

(1) The 'sandwich-course effect': the next stage of education increases its input level and previous intake-levels are no longer accepted.

(2) The diluting of the value of the COSC results: Teachers are generally short of time to produce a reasonable preparation for COSC. If PESC is offering an alternative entry, they might be tempted to leave COSC for what it is is and make sure students pass the PESC selection test, thus leaving a substential number of students in the doldrums.

As positive aspects of pre-entry courses may be mentioned:

(1) The pre-entry concept is gaining general acceptance, also with other faculties at this university. One could therefore foresee the future establishment of a Faculty of Basic Studies as in West-Africa.

(2) The intended changes at junior secondary level will undoubtly lead to loss of 'academic' content in favour of more 'vocational' content. Although this will produce a definite beneficial effect on the experimental skill of prospective science students there will be a need to make up for the loss in content. Originally the basic educational structure: primary-junior secondary-senior secondary was 7-3-2 years, but with the changes in the curriculum a 6-3-3 structure was suggested. The latest indications are however, that the old structure will be maintained. If this is the case then a Faculty of Basic Studies would be a way to correct for this.

2. Factors Which Will Influence the Position of Pre-Entry Courses

2.1 Senior Secondary Examinations

As long as the COSC examinations are external, there will not be an immediate pressure on the pre-entry recruitment. However when local examination councils are established (as for J.C.) then the recruitment procedures need revision, and this will have an immediate effect on the role of pre-entry courses.

2.2 Community Service

At present, the plans for Community Service in Botswana are still on the drawing-table, although some pilot-projects have started. If the community service would be of an obligatory character, the pre-entry concept would need some thorough revision (e.g. pre-entry before, during or after community service?)

2.3 Changes in Educational Structure

As already observed above, changes in the basic educational structure (6-3-3 or 7-3-2) and the possible establishment of other pre-entry courses will put up big question marks for the value of the COSC examination. The particular interests of the university need to be weighed against the overall training requirement beyond ordinary level and if this turns out in favour of maintaining COSC as a validity instrument, then the pre-entry courses will have to find some compromise.

3. Conclusion

At present, most factors point in the direction of a continuation of the pre-entry courses. However, the factors mentioned in para. 2 need constant monitoring.

The realization that pre-entry courses acquire a permanent character produces at the same time the need for localization of the staff. The pre-entry courses will have to participate in the scramble for local staff together with other departments at the university. The present success-rate of these departments on this record bodes ill for a complete localization in say 5 years, but one could expect about 2 to 3 local staff in such a period.

11th November, 1981
GABORONE.

GdeJ/fjm

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UNIVERSITY COLLEGE OF SWAZILAND

SCIENCE PRE-ENTRY COURSE AND THE SCIENCE TEACHER UPGRADING IN THE EDUCATIONAL SYSTEM.

The problems of science/mathematics teaching and the resulting inability of the Swaziland High Schools to produce candidates adequately qualified to enter the tertiary institutions led to the drawing up of plans for the establishment of the Science Pre-Entry Course (SPEC) and Science Teacher Upgrading (STU).

The SPEC was conceived as an emergency measure to improve the quality and to increase the quantity of students entering the Faculty of Science. The objective was to attempt to produce more graduates who might join the schools as teachers of science, mathematics and hopefully raise the standard of teaching. It was also recognized that once this objective had been met the need to continue SPEC would cease.

The state of science/mathematics teaching also affects William Pitcher Teacher Training College, (WPTTC) the Swaziland College of Technology (SCOT) and the Institute of Health Sciences (IHS). It was hoped that 80 of the 120 students enrolled in SPEC would be selected for the Faculty of Science (FOS) and the rest chanelled to the 3 tertiary institutions. Progress in this respect has been made towards supplying candidates for William Pitcher, but the other Colleges have other ways of selecting their candidates. It seems therefore that the SPEC efforts must concentrate on the FOS and WPTTC candidates in the future.

SPEC

The following table shows the FOS enrolment 1974-1981. The 1981-82 3rd year class is a product of SPEC.

Table I: FULL-TIME STUDENT ENROLMENT IN B.SC., 1974/75 - 1981/82

PERIOD	YEAR OF STUDY			
	1	2	3	4
1974/75	35	46	-	-
1975/76	33	37	-	-
1976/77	45	28	-	-
1977/78	55	43	-	-
1978/79	58	46	-	-
1979/80	74	45	-	-
1980/81	77	73	-	-
1981/82	81	69	17 54	- 8

REGIONAL MEETING ON BASIC SCIENCE PROJECTS

SCIENCE TEACHER UPGRADING PROJECT

FACULTY OF EDUCATION - SWAZILAND

The purpose of the Science Teacher Upgrading programme, operating within the In-service Department of the UCS Faculty of Education since 1979, is to assist Swaziland in minimising educational problems related to the quality of teaching the mathematics/science subjects by teachers holding the qualification (STC) for teaching in secondary schools.

The effectiveness of the programme in achieving this basic goal is assumed, it has not as yet been assessed; nevertheless, there are important advantages in having established and in retaining the STU which may be cited as follows:

1. the UCS has been able to extend the in-service training of teachers from the Humanities subjects which began in 1975 to the Science subjects, through the incentives afforded by a Diploma in Education award. Previous internal attempts at providing in-service training of teachers in the sciences were unsuccessful due to manpower shortages in both the Faculties of Education and Science. Hence the commencement of the extended SPEC in the Faculty of Science and the willingness of NUFFIC to extend the services of the SPEC staff, provide a coordinator for the Faculty of Education was a tremendous relief in providing in-service training of teachers for nearly all of the most basic subjects of the school. 54% of the first group of diplomates in the sciences completed the programme within the required two year period. Registrations in consequent years are as shown below:

Year of registration	No. registered	Completers	drop-outs	remarks
1979	37	20	11	6 to complete in 1982
1980	15	5	-	-
1981	14	-	-	-

The STU programme draws its students from the group labled MT in table 2. It will be seen that this target group forms the largest number of trained teachers in the secondary/high schools at present. Most of the candidates are the product of the local Teachers College whose annual output lies between 12 and 15 STC's in the sciences;hence, the numbers for the STU programme will probably always remain small.

2. the STU project has provided an opportunity for in-country in-service of teachers in the sciences, whereas previously, teachers were sent abroad on various technical assistance schemes after attaining the basic teachers certificate. The STU facilities for in-country in-service are closely related to the Swaziland situation and do not interrupt the stability of the teaching force in the schools.

3. It has always been the hope of Swaziland educators that secondary schools may be staffed with a greater number of teachers at the Bachelors degree level. The incorporation of the STU into the Diploma in Education provides the means for entry into the second year of the Bachelor of Education degree for teachers, thus cutting down on the number of years that a teacher may spend away from his duty station.

The Future

An In-service Department exists to ensure the continual improvement of teachers' classroom performance. The specific forms of training existing within the department are often a response to existing needs. Presently, the thrust is for the upgrading of teachers with a basic teachers qualification and this role is expected to continue for as long as it has not as yet been possible to alter the structure of STC in the College. Presently preparations are underway fro an improved STC and we may expect the earliest output of this effort around 1985.

Considering the overall intention of training in Swaziland for localisation of staff in the schools table 1 shows that the maths/science teaching force exhibits the highest manpower shortages among the compulsory school subjects. The expected sizeable increase of maths/science graduate teachers beginning in June 1983, due to SPEC, will ease the pressure for Swazi teachers in these subjects. However, it is expected that the bulk of the teachers who are presently unqualified (32% maths and 22% science) will retain their jobs and remain in the schools. Their teaching experience will possibly be of value when the effects of the country's Universal Primary Education by 1985 will spill into the secondary school enrolments. It is our interest to ensure that continual inservice provisions for the unqualified teachers exist.

Further, on the question of the stability of the Maths/Science teachers fluctuates (the present attrition rate is estimated at 6% in the secondary schools) because of the various developmental openings springing up in the country. Some of these teachers especially the more capable ones are of course placed within the education system for such needy areas as exist in the Teacher Colleges, Education administration etc. It does mean that those who remain in the schools must be assisted towards proficiency.

On the question of teaching and organising staff for the STU, the Faculty of Education has relied on the good services of SPEC and its coordinator Mr. Lubben. A localisation strategy is underway. Preparations are being made to secure a counterpart for the coordinator at the beginning of 1982 and the salary of the counterpart is guaranteed by EDF till 1985. The period between 1982 and 1985 will provide the UCS with sufficient time to establish a post for continuation of the programme. Further, the UCS has already established two posts for Mathematics and Physical Science within the Faculty of Education. The persons to fill these posts are expected in 1982 and will be valuable in complementing the work done by the SPEC team for the STU programme.

BONGILE PUTSOA.

TABLE Ia

APPENDIX

NUMBER OF QUALIFIED TEACHERS BY
SUBJECT AND CITIZENSHIP

1979

SUBJECT	TOTAL TEACHERS	NO OF QUALIFIED SWAZI TEACHERS	PERCENTAGE OF TOTAL TEACHERS	TOTAL NO. OF QUALIFIED TEACHERS	PERCENTAGE OF TOTAL TEACHERS
Agriculture	60	22	36.7	49	81.7
Commercial Subjects	55	35	63.6	49	89.1
English	304	154	50.7	241	79.3
Geography	194	102	52.6	136	70.1
History	248	139	56.0	183	73.8
Home Economics	55	28	50.9	39	70.9
Mathematics	209	75	35.9	146	69.9
Science	244	104	42.6	193	79.1
siSwati/ Zulu	226	119	52.7	133	56.8
Technical Subjects	38	18	47.4	36	94.7
ALL TEACHERS*	1,149	510	44.4	853	74.2

*Includes teachers of subjects other that those listed above. Also as a teacher may be qualified in more than one subject, the total of teachers by subject is greater than the actual total of all teachers.

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TABLE Ib

APPENDIX

NUMBER OF QUALIFIED TEACHERS BY SUBJECT AND CITIZENSHIP

1980

SUBJECT	TOTAL TEACHERS	NO OF QUALIFIED SWAZI TEACHERS	PERCENTAGE OF TOTAL TEACHERS	TOTAL NO. OF QUALIFIED TEACHERS	PERCENTAGE OF TOTAL TEACHERS
Agriculture	59	35	59.3	57	96.5
Commercial Subjects	50	32	68.1	39	78.0
English	318	169	53.2	254	79.9
Geography	196	121	61.7	145	74.0
History	253	154	60.9	196	77.5
Home Economics	66	41	62.1	47	71.2
Mathematics	214	71	33.2	146	68.7
Science	265	113	42.6	207	78.1
SiSwati/Zulu	210	126	60.0	137	65.2
Technical Subjects	46	25	54.4	46	100.0
ALL TEACHERS*	1250	605	48.4	929	74.3

*Includes teachers of subjects other than those listed above. Also as a teacher may be qualified in more than one subject, the total of teachers by subject is greater than the actual total of all teachers.

TABLE 2

TEACHERS IN SECONDARY SCHOOLS BY QUALIFICATION AND CITIZENSHIP

1. MATHEMATICS

	1979						1980					
	GT	GU	MT	MU	U	TOTAL	GT	GU	MT	MU	U	TOTAL
Swazi	3	-	72	58	4	137	3	1	67	62	3	136
Non-Swazi	42	18	11	1	-	72	46	18	11	3	-	78
Total	45	18	83	59	4	209	49	19	78	65	3	214
% Swazi	6.7	-	86.7	98.3	100.0	65.6	6.1	5.3	85.9	95.9	100.0	63.6

2. SCIENCE

	1979						1980					
	GT	GU	MT	MU	U	TOTAL	GT	GU	MT	MU	U	TOTAL
Swazi	24	5	75	45	2	151	22	3	89	54	1	169
Non-Swazi	49	30	10	4	-	93	51	31	11	3	-	96
Total	73	35	85	49	2	244	73	34	100	57	1	265
% Swazi	32.9	14.3	88.2	91.8	100.0	61.9	30.1	8.8	89.0	94.7	100.0	63.8

SOURCE: 1979 and 1980 reports of the Ministry of Education Planning section

NOTES:

1. GT - graduate with teachers qualification
   GU - graduate without teachers qualification
   MT - matric level with teachers qualification e.g. STC
   MU - matric level without teachers qualificaltion
   U - below matric level

2. There is an overlap between maths ans science teachers; e.g. the total 1980 MT group is less than 156

P/4 Postion of the projects in the educational system (SPEC/STU team)

After some years of teaching SPEC,it is important to find out, what is the impact/benefit of all these efforts for the science education in Swaziland.

The following points can be considered:

-The science department of the William Pitcher's TTC **teaches** 17 students at **this** moment.10 Out of this group qualified for their course via SPEC.The maximum intake of the science dep. of WP is about 24.

The intake of the FOS of UCS is nearly doubled (40 to 80) as a result of SPEC,without lowering the FOS standards

-The intake of students by other institutions is relatively low and consequently the influence of SPEC upon the standards and level of their intake is also smaal

-A small evaluation report,investigating the performance of the Agriculture Diploma students ,shows in the beginning **much** better results of our SPEC students in that course,but the benefit was diluted to an insignificant increase in diploma results at the end

-The higher intake in the first year in the fac. of Science increased the numbers of third year science students drastically .

At the moment there are 54 students in the third year leading to approx. 40 to 50 BSc's.

The greater number of BSc students will ultimately lead into a greater number of qualified degree **teachers** for high schools .

At the moment all students have to do education so all students can teach after their degree .

The ideal length of the course

We feel that 6 months is long enough to give the weak students time to catch up and to present a reasonable program,a longer course will lose its upgrading/introductory effect.After 6 months the students are happy to enter the REAL university or found a place at one of the institutions.

The short time between the start of the course (end Jan.) and the channeling (middle May) leaves the SPEC staff hardly time enough to do a proper selection.(Special because capable,but disadvantaged students should have time to catch up)

Institutionalised or gradually phased out ??

The two real benefitting institutions are the FOS and the WP secondary Teacher Training College, in both cases their intake is increased. The increased intake of FOS will also result in more students opting for a degree in Agriculture after 1 year science. Till sofar the Agriculture degree program was hardly justified because of small classes.

The following considerations have to be taken into account in the discussions about the future of SPEC

- As the O'level results are improving (slowly), it will be possible in the near/far future to recruit enough students for FOS and WP with adequate O-level results. The main fuction of SPEC will be upgrading then.
- Careful manpowerplanning should sort out the need for science teachers as well as the job oppotunities for BSc's in industries. Better coordination between university, Ministry, A-level schools and Industries would be desirable
- A greater intake in the first year science will also lead to a higher total number drop-outs. Is it possible to fit these drop-outs in the education system again ?

After discussions in SPEC and with theUniversity authorities the future of SPEC is considered as follows:

1. SPEC should not become a department of FOS, because
   - Impact of SPEC still not very clear. First graduates, who followed SPEC, will graduate in 1983 so it is difficult to draw conclusions of how SPEC changes Swaziland
   - Making SPEC a department will give SPEC a permanent character
   - SPEC will loose its independent character if attached to close to the FOS
2. SPEC as a temporary program should not be localized as first priority because:- there is no qualified Swazi-staff, who want to teach in SPEC. Localisation of FOS has higher priority.
   - SPEC as a temporary program offers only temporary employment
3. Our recommendation is to continue with SPEC up to at least 1985 and evaluate SPEC in that year. More data is available then about the effect of SPEC upon the science education in Swaziland.

MEETING ON PRE-ENTRY SCIENCE COURSES/SCIENCE TEACHERS' UPGRADING PROGRAMMES

Lesotho, 2 - 5 December 1981

POSITION PAPER P/4 'Need for improvement of Post School Certificate Training'

Prof.Dr. N.O.H. Setidisho, parts from internal FUA report 1981

1. There is a general complaint about the standards of the university but it has never been altogether clear what is meant and what the expectations are. One thing that can be said is that people are comparing what cannot and should not be compared and they tend to forget the consequences of independence and the process of rapid localisation. In this situation, it should be expected that initially the standards of work efficiency will fall and then gradually pick-up over time. This situation occurs for the following reasons:

   1) An Ordinary level entry requirement to degree studies is inadequate and is not acceptable in many parts of English speaking Africa.
   2) Degree studies in many former British colonies extend over a period of five years after the School Certificate.
   3) Academic and theoretical training does not automatically guarantee competence on the job.
   4) Many young graduates are placed in positions of responsibility too soon after graduation long before they have gathered practical experienced in a job situation.
   5) They are not afforded an opportunity to work with and alongside their more experienced colleagues.
   6) Very often their senior colleagues also have very limited work experience, and they themselves are not aware of their own limitations.

2. In terms of academic content, there is a wide gap between O-level work and degree studies, and there is a need to bridge the gap. In addition, a great deal of remedial work is necessary.
   The O-level entry requirement to degree studies has at least two consequences:

   1) Either degree teaching ignores the academic level of the students, and it is assumed that there is no gap between the two levels of education with the inevitable result that there is a high rate of failure and expecially in the sciences; or
   2) The level of degree teaching is lowered and time is spent on remedial work and the upgrading of the students.
      Under these circumstances, the quality of the degree in comparison with others elsewhere, becomes questionable and this has been the case.

3. The Boleswa Region could possibly consider the feasibility of a five year cycle of education leading to a degree after the Cambridge Overseas School Certificate. Various permutations exist which could be examined in terms of being realistic, efficient and cost-effective.

4. The idea of a Pre-University Course may be easily accepted in all the countries in the Boleswa Region. But it may not necessarily be easy to sell the idea of a five year study period after the O-level. It would appear that there are at least three possible alternatives which could be explored.

   1) A one year Pre-University Course (12-18 months) for potential science students to be followed by four years of degree studies.
      - The degree structure to consist of Part I (two years) and Part II (two years). This structure would be maintained in order to allow for transfers in special cases.
      - The course would be controlled and managed locally.

   2) Two year Pre-University Course (24-30 months) to be followed by three years of degree studies.
      - The degree structure to be an integrated unified three year course.
      - The control and management would be the same as for the first alternative.

   3) Two year Pre-University course which could be the usual A-level which is controlled from Cambridge. There are several Examination Boards to choose from. The degree programme would then extend over a period of three years.